

NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS
DIAMOND INTERNATIONAL (U) CORPS OF ENGINEERS WALTHAM
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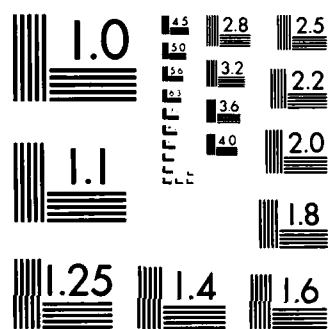
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CONNECTICUT RIVER BASIN
PALMER, MASSACHUSETTS

DIAMOND INTERNATIONAL CORPORATION
UPPER DAM
MA 00562

**PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM**



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DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS. 02154

OCTOBER 1980

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) The dam is a run-of-the-river type structure consisting of a 17 ft. high concrete overflow spillway and a 13 ft. high rockfill dike. The total height of the structure is 23 ft. from the top of the dike to the streambed at the toe of the spillway. There are deficiencies which must be corrected to assure the continual performance of this dam. The dam has been classified as intermediate in size with a hazard potential of high.		

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DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
424 TRAPELO ROAD
WALTHAM, MASSACHUSETTS 02254

REPLY TO
ATTENTION OF:

NEDED

Honorable Edward J. King
Governor of the Commonwealth of
Massachusetts
State House
Boston, Massachusetts

Dear Governor King:

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JUL 07 1981



Inclosed is a copy of the Diamond International Corporation Upper Dam (MA-00562) Phase I Inspection Report, prepared under the National Program for Inspection of Non-Federal Dams. The report is based upon a visual inspection, a review of past performance, and a preliminary hydrological analysis.

The preliminary hydrologic analysis has indicated that the spillway capacity for the Diamond International Corporation Upper Dam would likely be exceeded by floods greater than 10 percent of the Probable Maximum Flood (PMF). Our screening criteria specifies that a dam classified as high hazard with a spillway capacity insufficient to discharge fifty percent of the PMF be judged as having a seriously inadequate spillway. As a result this dam is assessed as unsafe, non-emergency until more detailed studies prove otherwise or corrective measures are completed.

The term "unsafe" applied to a dam because of an inadequate spillway does not indicate the same degree of emergency as it would if applied because of structural deficiency. It does indicate, however, that a severe storm may cause overtopping and possible failure of the dam, with significant damage and potential loss of life downstream.

We recommend that within twelve months from the date of this report the owner of the dam engage the services of a qualified registered engineer to determine further the potential of overtopping the dam and the need for and the means to increase project discharge capacity. Based on this determination, appropriate remedial mitigating measures should be designed and completed within 24 months of this date of notification. In the interim a detailed emergency operation plan and warning system should be promptly developed and round-the-clock surveillance should be provided during periods of heavy precipitation or high project discharge.

JUL 07 1981

NEDED

Honorable Edward J. King

I approve the report and support the findings and recommendations described in Section 7, with qualifications as noted above. I request that you keep me informed of the actions taken to implement these recommendations since this follow-up is an important part of the program.

Copies of this report have been forwarded to the Department of Environmental Quality Engineering and to the owner, Diamond International Corporation, Palmer, Mass. Copies will be available to the public in thirty days.

I wish to thank you and the Department of Environmental Quality Engineering for your cooperation in this program.

Sincerely,

A handwritten signature in dark ink, appearing to read 'C. E. Edgar, III', with a stylized flourish at the end.

C. E. EDGAR, III
Colonel, Corps of Engineers
Commander and Division Engineer

DIAMOND INTERNATIONAL CORPORATION UPPER DAM

MA 00562

CONNECTICUT RIVER BASIN
PALMER, MASSACHUSETTS

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION
PROGRAM

NATIONAL DAM INSPECTION
PROGRAM

PHASE I INSPECTION REPORT

BRIEF ASSESSMENT

Identification No.: MA00562

Name of Dam: Diamond International Corporation Upper Dam

Town: Palmer

County and State: Hampden County, Massachusetts

Stream: Ware River, tributary of the Chicopee River

Date of Inspection: July 17, 1980

The Upper Dam of Diamond International Corporation was built in 1918 and is a run-of-the-river type structure consisting of a 17-foot-high concrete overflow spillway and a 13-foot-high rockfill dike. The total height of the structure is 23 feet from the top of the dike to the streambed at the toe of the spillway. The spillway is a 174-foot-long ogee weir, with stone masonry and gunite sidewalls at the abutments. The crest of the weir is at El 362.4 (National Geodetic Vertical Datum of 1929), and the top of the dike is at El 368.0. The dike is approximately 160 feet long. There is no outlet at the spillway or dike.

Water can be diverted from the Ware River through a wooden gate house west of the dam to a canal for the Diamond International plant. This water is used for processing, and for generating electrical power at the factory, or may be released to the river upstream of the factory.

There are deficiencies which must be corrected to assure the continued performance of this dam. This conclusion is based on the visual inspection of the site and a review of the available data. Generally the dam is in fair condition.

The following deficiencies were observed at the site: lack of low-level outlet; leakage at the base of the side walls of the main spillway spalled concrete on the weir; and heavy growth of brush and trees on the dike and in the downstream channel.

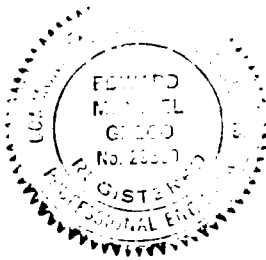
Based on Corps of Engineers' guidelines, the dam has been classified in the intermediate size and high hazard categories. A test flood equal to the probable maximum flood (full PMF) was used to evaluate the capacity of the spillway. The test flood outflow

DIAMOND INTERNATIONAL CORPORATION UPPER DAM

is 89,180 cfs, resulting in a pond level at El 387.0. The test flood would overtop the dike by 19 feet. Hydraulic analyses indicate that the spillway can discharge 9,210 cfs, or 10 percent of the test flood outflow before the dike is overtopped.

It is recommended that the Owner employ a qualified registered professional engineer to conduct a more detailed hydraulic and hydrologic study of the spillway, design a low-level outlet, evaluate the leakage through and the stability of the dike and spillway, and develop procedures for clearing brush and trees, and backfilling the dike embankment. In addition, the Owner should repair the deficiencies listed above, as described in Section 7.3. The Owner should also implement a program of annual technical inspections, a plan for surveillance of the dam during and after periods of heavy rainfall, and a plan for notifying downstream residents in the event of an emergency at the dam.

The measures outlined above and in Section 7 should be implemented by the Owner within a period of 1 year after receipt of this Phase I Inspection Report.



A handwritten signature of Edward M. Greco in cursive script.

Edward M. Greco, P.E.
Project Manager
Metcalf & Eddy, Inc.

Massachusetts Registration
No. 29800

Approved by:

A handwritten signature of Stephen L. Bishop in cursive script.

Stephen L. Bishop, P.E.
Vice President
Metcalf & Eddy, Inc.

Massachusetts Registration
No. 19703



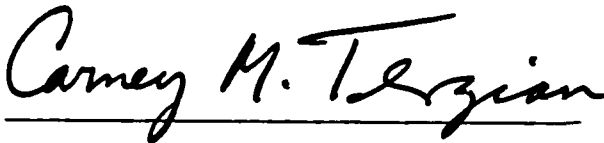
DIAMOND INTERNATIONAL CORPORATION UPPER DAM

Diamond International Corporation

This Phase I Inspection Report on Upper Dam (MA-00562) has been reviewed by the undersigned Review Board members. In our opinion, the reported findings, conclusions, and recommendations are consistent with the Recommended Guidelines for Safety Inspection of Dams, and with good engineering judgement and practice, and is hereby submitted for approval.



ARAMAST MAHTESIAN, MEMBER
Geotechnical Engineering Branch
Engineering Division

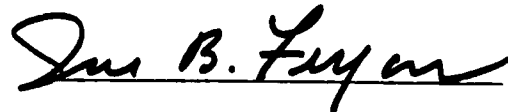


CARNEY M. TERZIAN, MEMBER
Design Branch
Engineering Division



JOSEPH W. FINEGAN, JR., CHAIRMAN
Water Control Branch
Engineering Division

APPROVAL RECOMMENDED:



JOE B. FRYAR
Chief, Engineering Division

PREFACE

This report is prepared under guidance contained in Recommended Guidelines for Safety Inspection of Dams, for a Phase I Investigation. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigations, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions will be detected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Spillway Test Flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. Because of the magnitude and rarity of such a storm event, a finding that a spillway will not pass the test flood should not be interpreted as necessarily posing a highly inadequate condition. The test flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general conditions and the downstream damage potential.

The Phase I Investigation does not include an assessment of the need for fences, gates, no-trespassing signs, repairs to existing fences and railings and other items which may be needed to minimize trespass and provide greater security for the facility and safety to the public. An evaluation of the project for compliance with OSHA rules and regulations is also excluded.

DIAMOND INTERNATIONAL CORPORATION UPPER DAM

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SECTION 3
VISUAL INSPECTION

3.1 Findings

- a. General. The Phase I Inspection of the dam at the Upper Dam at Diamond International Corporation was performed on July 17, 1980. A copy of the inspection checklist is included in Appendix A. Previous inspections were conducted by Tighe & Bond, Inc., for the Hampden County Engineers office from 1954 to 1960, and by the Massachusetts Department of Public Works in 1972. Copies of selected reports and related correspondence are given in Appendix B. Selected photographs taken during our Visual Inspection are included in Appendix C.

Although not a structural part of the Upper Dam, the factory canal and its appurtenant structures were inspected as part of the water control system for the Diamond International factory complex. Details of the inspection of these structures are included in the inspection checklist, and their general condition can be seen in Photographs 7 through 13 of Appendix C.

- b. Dam. The dam is a run-of-the-river type structure consisting of a concrete spillway and rockfill dike. A significant amount of leakage was noted at two locations at the spillway: at the toe of the weir adjacent to the right sidewall (see Photo No. 2) and at the base of the left sidewall (Photo No. 4). In both cases the flowing water is clear, although as shown on Photo No. 4, the leakage has caused some iron staining of the bedrock outcrop below the wall. A strong sulfur smell was also noted at the site of the leak. At the time of the inspection, no water was flowing over the spillway crest. However, the leakage, estimated at 2 to 3 gpm, has created a pool of water in the channel below the spillway (see Photo No. 3).

The concrete of the weir appears to be in good condition. The gunited surface of the weir generally shows only minor cracking and spalling. Two vertical construction joints, about 1/2-inch wide, are visible on the downstream face, and apparent spalling has widened one joint to about 4 inches at the toe. A small patch of rusted wire mesh is exposed at the toe of the weir, beneath the gunite.

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- c. Validity. Comparison of a 1955 drawing of the dike with the field survey conducted during the Phase I inspection indicates that the available information does not exactly represent existing conditions. The actual top of the dike is approximately 3 feet higher and 2 to 3 feet wider than that shown on the plan. Also, although the plan shows 3:1 and 2:1 upstream and downstream slopes, respectively, the survey taken during our visual inspection indicated 2:1 slopes on both sides of the dike. Both slopes were too heavily overgrown with vegetation to determine the existence of any large riprap as indicated on the plan.

SECTION 2

ENGINEERING DATA

- 2.1 General. The engineering data available for this Phase I inspection includes one drawing of the proposed rockfill dike, dated September 6, 1955 prepared by Harrison G. White, Co. Engineers. The drawing was obtained from the Hampden County Engineers office. There are no other drawings, specifications, or computations available from the Owner, State, or County agencies. Copies of previous inspection reports dated 1954 to 1960, prepared by Tighe & Bond, Inc., for Hampden County are available at the County Engineers office. Selected correspondence regarding the condition of the dam and status of repairs are included in Appendix B. The most recent inspection was conducted in 1972 by the Massachusetts Department of Public Works. A copy of that report is also given in Appendix B.

We acknowledge the assistance and cooperation of personnel from the Massachusetts Department of Environmental Quality Engineering, Division of Waterways; the Massachusetts Department of Public Works; and the Hampden County Engineers Office. In addition, we acknowledge the assistance of Mr. John Korabowski and Mr. Joseph Szlosek, of Diamond International Corp., who provided a property map of the factory complex, and information on the history and operation of the dam.

- 2.2 Construction Records. There are no construction records or as-built drawings available for the dam or appurtenances. Previous inspection reports by the Hampden County Engineers provided some construction information, and a summary of repairs and post-construction changes at the site.
- 2.3 Operating Records. No operating records are available, and there is no daily record kept of the elevation of the pool or rainfall at the dam site.
- 2.4 Evaluation
- a. Availability. There is limited engineering data available for this dam.
 - b. Adequacy. The lack of detailed hydraulic, structural and construction data did not allow for a definitive review. Therefore, the evaluation of the adequacy of this dam is based on the visual inspection, past performance history, and engineering judgment.

DIAMOND INTERNATIONAL CORPORATION UPPER DAM

- (2) Size: 5 feet wide by approximately 6 feet high
- (3) Description: 5 wooden slide gates regulate flow into factory canal, which provides power for turbines, and process water.
- (4) Control mechanism: rack and pinion mechanisms inside gate house which spans canal
- (5) Other: water which enters canal via canal gatehouse may bypass factory intakes through canal spillway and low-level outlet

Low-level outlet at canal spillway

- (1) Invert El: 349.6
- (2) Size: 4-foot square
- (3) Description: wooden slide gate in outlet structure constructed of granite blocks, at left abutment of canal spillway
- (4) Control mechanism: rack and pinion mechanism on top of headwall of outlet structure
- (5) Other: Discharge from low-level outlet enters channel of canal spillway and rejoins Ware River Channel. There is no low-level outlet at the main spillway and dike.

- (8) Cutoff: none
- (9) Grout curtain: none
- (10) Other: constructed of riprap, backfilled with gravel and cobbles, designed as temporary structure to act as emergency spillway.

1. Spillway

Main spillway on Ware River

- (1) Type: concrete ogee weir
- (2) Length of weir: 174 feet
- (3) Crest elevation: 362.4
- (4) Gates: none
- (5) Upstream channel: Ware River
- (6) Downstream channel: Ware River. Channel is approximately one-half of the width of spillway/dike structure.

Canal Spillway

- (1) Type: narrow crest, stone masonry with 9 bays of flashboards
- (2) Length of weir: 49 feet; effective length is 45.8 feet
- (3) Crest elevation: with flashboards - variable (approximately) without flashboards - 358.9
- (4) Gates: none
- (5) Upstream channel: factory canal, excavated and lined with riprap and gunite on sides
- (6) Downstream channel: unlined channel approximately 65 feet wide and 75 feet long, leads to Ware river channel.

j. Regulating Outlets

Intake to factory canal

- (1) Invert El: 351.9

- (4) Top of dam: 18,750
- (5) Test flood pool: 36,460

e. Storage (acre-feet)

- (1) Normal Pool: 780
- (2) Flood control pool: N/A
- (3) Spillway crest pool: 780
- (4) Top of dam: 1,980
- (5) Test flood pool: 14,780

f. Reservoir surface (acres)

- (1) Normal pool: 135
- (2) Flood-control pool: N/A
- (3) Spillway crest: 135
- *(4) Test flood pool: 1,130
- *(5) Top of dam: 290

g. Dam

- (1) Total length: 334 feet (includes dike)
- (2) Total height: 23 feet

h. Dike

- (1) Type: rockfill
- (2) Length: 160 feet
- (3) Height: 13 feet
- (4) Top width: 12 feet
- (5) Side slopes: upstream: 3:1
downstream: 2:1
- (6) Zoning: none
- (7) Impervious core: none

*Surface area will significantly increase with changes in pool elevation from 362.4 to 387.0.

DIAMOND INTERNATIONAL CORPORATION UPPER DAM

- (4) Ungated spillway capacity at test flood elevation:
49,170 cfs at El 387.0.
- (5) Gated spillway capacity at normal pool elevation:
N/A
- (6) Gated spillway capacity at test flood elevation:
N/A
- (7) Total spillway capacity at test flood elevation:
49,170 cfs at El 387.0.
- (8) Total project discharge at top of dam elevation:
9,210 cfs at El 368.0.
- (9) Total project discharge at test flood elevation:
89,180 cfs at El 387.0.

c. Elevation (feet above National Geodetic Vertical Datum of 1929 (NGVD)). A benchmark was established at El 365.38 at the canal bridge at Pleasant Street. This elevation is taken from a brass disc set by a Massachusetts Department of Public Works Survey.

- (1) Streambed at toe of spillway: 345.0
- (2) Bottom of cutoff: unknown
- (3) Maximum tailwater: unknown
- (4) Normal pool: 362.4
- (5) Full flood control pool: N/A
- (6) Spillway crest: 362.4
- (7) Design surcharge (Original design): unknown
- (8) Top of dam: 368.0 (rockfill dike)
- (9) Test flood surcharge: 387.0

d. Reservoir (Length in feet)

- (1) Normal pool: 11,460
- (2) Flood control pool: N/A
- (3) Spillway crest pool: 11,460

DIAMOND INTERNATIONAL CORPORATION UPPER DAM

Previous inspection reports indicate that since construction, the dam has been in good to excellent condition. A "small amount" of leakage has been noted under both abutments of the spillway, but was not considered to be serious. Some repairs were made to the structure in 1956 and 1958. This included removal of spalled concrete from the face of the spillway, and application of a gunite coating. In addition minor repairs and guniting were completed at the canal spillway (see specifications, page B-9). The last record of repairs at the site is in 1966, at which time more gunite was applied to the spillway, and the left side wall was widened.

1. Normal Operating Procedures. Personnel from Diamond International reportedly visit the dam "periodically" to check the condition of the gatehouse and slide gates on the canal, since a constant flow to the turbines must be maintained. The flashboards on the canal spillway are operated only when conditions in the factory, or potential flooding necessitate lowering the water level in the canal. It is not known when the low-level outlet was last operated.

1.3 Pertinent Data

- a. Drainage Area. The 138,000-acre (215.6 square mile) drainage area extends northeastward into the towns of Palmer, Ware, Hardwick, New Braintree, Barre, Rutland and Hubbardston, Massachusetts. The land is gently rolling to hilly, wooded and mostly undeveloped. There are numerous dams associated with recreational ponds and water supply reservoirs upstream of the Upper Dam on the Ware River and its tributaries. Barre Falls Dam is located approximately 20 miles upstream of Diamond International, and the reservoir at Barre Falls is the largest in the watershed. The dam was constructed by the U.S. Army Corps of Engineers for flood control within a 55 square mile drainage area. The dam and reservoir were designed with available flood control storage equal to 8.2 inches of runoff.
- b. Discharge. Discharge from the Upper Dam flows over the spillway into the Ware River Channel. There is no low-level outlet at the dam. Water in the canal discharges over the flashboards at the canal spillway, and through the low-level outlet into a channel which connects to the Ware River.
 - (1) Outlet: none
 - (2) Maximum known flood at damsite: unknown
 - (3) Ungated spillway capacity at top of dam: 9,210 cfs at El 368.0.

DIAMOND INTERNATIONAL CORPORATION UPPER DAM

- d. Hazard Classifications. Several industrial buildings and a parking lot for Diamond International Corporation are located on the flood plain between the Ware River and the canal dike (see Overview, and Flood Impact Area on Location Map). Pleasant Street crosses the river and canal at two bridges about 1,000 feet downstream of the dam. A second factory complex is situated on the east bank of the river, just upstream of Pleasant Street.

An assumed failure of the main spillway or dike would produce a flood wave 18 feet deep at the Pleasant Street Bridge, as compared to channel flow 9 feet deep prior to failure. The flood wave would rise above the foundation level of the buildings on the east bank and inundate the parking lot with approximately 4 feet of water. There would be no flooding in this area prior to failure of the dam. More than a few lives could be lost, and excessive property damage could occur. Accordingly, the dam has been placed in the "high" hazard category.

- e. Ownership. The dam is owned by the Diamond International Corporation, Fiber Products Division, P.O. Box 230, Palmer, Massachusetts 01069. Mr. John Korabowski, Plant Engineer (telephone 413-283-8301) granted permission to enter the property and inspect the dam.
- f. Operator. The dam is operated by personnel from Diamond International Fiber Products Division.
- g. Purpose of the Dam. The dam is currently used by Diamond International to divert water into the canal for use in plant processing and for generating electrical power. The plant engineer estimates that 20 to 30 percent of the electrical power used by the plant is produced at the site. Diamond International manufactures paper egg cartons at this facility.
- h. Design and Construction. Construction of the Upper Dam was completed in 1918 to replace a wooden dam at the site. There are no design drawings or specifications available for the new dam.

In August, 1955, the earthfill embankment at the left abutment of the spillway was overtopped and washed out by flood waters. A "temporary" dike of rockfill which is still in use was constructed in its place. This dike was designed to divert water to the main spillway, and also to serve as an emergency spillway during exceptionally high flows in the river. Specifications, and a plan of the reconstruction, were prepared by Harrison G. White Co., Engineers (see pages B-6 and B-7 in the Appendix).

DIAMOND INTERNATIONAL CORPORATION UPPER DAM

There are five slide gates, each 5 feet wide by approximately 6 feet high, separated by 6-inch timber beams. The invert of the gates is at El 351.9, which is the elevation of the floor of the canal at this point.

Downstream of the gatehouse, beyond the stone retaining walls, the banks of the canal are lined with cobbles. The canal curves slightly to the west before flowing under the bridge at Pleasant Street, and into the Diamond factory complex, a distance of about 900 feet downstream from the gatehouse.

There is a spillway and outlet on the canal which allows flow to be discharged to the main channel of the Ware River. This spillway, located on the canal dike approximately 150 feet downstream of the gatehouse, consists of a narrow-crested, stone masonry weir with 9 bays of flashboards (Figure B-2). The spillway is 49 feet long, although the effective length is reduced to 45.8 feet due to bridge supports mounted on the weir. The crest of the canal spillway is at El 358.9, and the tops of the flashboards are at an approximate average elevation of 360. A wooden foot bridge spans the spillway. The invert of the bridge is at El 362.4.

The approach to the canal spillway is marked by a stone masonry side wall on the right (south) abutment, and a stone masonry outlet structure on the left abutment. Both walls are coated with gunite.

The discharge channel below the spillway is 65 feet wide. The sides are vertical stone walls which extend 20 feet downstream of the weir.

The low-level outlet for the factory canal is a 4-foot square, wooden slide gate, located in a masonry head wall at the left abutment of the canal spillway. The invert of the outlet is at El 349.6 at the upstream end. Flow into the outlet is controlled by a rack and pinion mechanism located on the top of the headwall. The outlet discharges into the channel of the spillway canal, and eventually into the Ware River.

- c. Size Classification. The Upper Dam at Diamond International Corporation has a maximum height of 23 feet and a maximum storage capacity of 1,980 acre-feet. The storage capacity places the dam in the "intermediate" size category which ranges from 1,000 to 50,000 acre-feet.

- b. Description of Dam and Appurtenances. The Upper Dam at Diamond International Corporation consists of a concrete and stone spillway and rockfill dike (see Plan of Dam and sections in Appendix B, and Photographs in Appendix C). The total height of the dam, from the top of the dike to the streambed at the toe of the spillway, is 23 feet. The spillway is 174 feet long and 17 feet high, with a concrete ogee weir and stone masonry sidewalls covered with gunite. The crest of the weir is at El 362.4, and the downstream toe is at El 345.0. The parallel side walls extend upstream into the river channel for a distance of approximately 60 feet from the crest of the weir. The tops of the walls are at El 368.4. Downstream of the spillway, the walls are stepped to the river bed, and are approximately 45 feet long. A 13-foot-high, 160-foot-long dike extends from the left (northeast) wall of the spillway easterly to the river bank. The top of the dike is approximately 12 feet wide, and at El 368.0. According to available information, the dike was designed as an unzoned embankment to be constructed of "large riprap, with cobbles and gravel filling the voids". As shown on Figure B-2, the dike has approximate 2:1 upstream and downstream slopes. Both slopes are obscured by a heavy growth of brush and trees.

There is no outlet structure at the spillway or dike. A 12-inch diameter cast iron pipe extends downstream from the toe of the weir. However, its purpose is unknown and no control mechanism was visible.

Downstream from the spillway the Ware River channel narrows to approximately 100 feet wide. The floor of the channel is naturally paved with boulders and cobbles.

Water from the Ware River can be diverted to a canal which conducts the flow to the factory intakes. The area between the canal and main river channel is protected by an earthfill dike which is parallel to the canal. The right side wall of the main spillway ties into a retaining wall on the upstream end of the canal dike, and extends downstream along the left (easterly) bank of the canal, beyond the canal gate house.

Flow into the factory canal is controlled by wooden slide gates located at the upstream end of the canal (see Figure B-2). At this point, the canal is approximately 25 feet wide and bounded by stone and concrete retaining walls. The slide gates are operated by rack and pinion mechanisms located inside the gate house which crosses the canal. The slide gates were submerged at the time of the inspection, and therefore their condition could not be evaluated. The floor of the gatehouse is supported by wooden beams and angle supports, and is 15.4 feet above the bottom of the canal.

NATIONAL DAM INSPECTION
PROGRAM

PHASE I INSPECTION REPORT

DIAMOND INTERNATIONAL CORPORATION
UPPER DAM

SECTION 1

PROJECT INFORMATION

1.1 General

a. Authority. Public Law 92-367, August 8, 1972, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a national program of dam inspection throughout the United States. The New England Division of the Corps of Engineers has been assigned the responsibility of supervising the inspection of dams within the New England Region. Metcalf & Eddy, Inc. has been retained by the New England Division to inspect and report on selected dams in the State of Massachusetts. Contract No. DACW 33-80-C-0054, dated April 18, 1980, has been assigned by the Corps of Engineers for this work.

b. Purpose

- (1) Perform technical inspection and evaluation of non-Federal dams to identify conditions which threaten the public safety and thus permit correction in a timely manner by non-Federal interests.
- (2) Encourage and assist the States to quickly initiate effective dam safety programs for non-Federal dams.
- (3) Update, verify and complete the National Inventory of Dams.

1.2 Description of Project

a. Location. The dam is located on the Ware River in the Town of Palmer, Hampden County, Massachusetts, in the Connecticut River Basin (see Location Map). The dam is about 2.1 miles upstream of the confluence with the Swift River. The coordinates of this location are Latitude 42 deg. 11.3 min. north and Longitude 72 deg. 19.5 min. west.

DIAMOND INTERNATIONAL CORPORATION UPPER DAM

OVERVIEW
DIAMOND INTERNATIONAL CORPORATION UPPER DAM
PALMER, MASSACHUSETTS



The approach channel and crest of the weir are clear of debris. The vertical sidewalls, which extend from upstream to downstream of the weir, are thickly coated with gunite and, except at the leakage points, appear to be in good condition. The right side wall appears to tie into the canal dike to the west, while the left side is essentially free-standing downstream of the weir. Minor cracking and efflorescence is visible on both walls, and moderate spalling at the base of each wall has exposed the stone masonry construction beneath the gunite. Both walls show slight staining to the approximate level of the crest of the weir (see Photos 1 and 3).

The heavy growth of brush and trees prevented a thorough inspection of the rockfill dike. As shown on Photographs No. 5 and 6, the top of the dike is flat and clear, and paved with gravel and cobbles. The upstream slope is also lined with cobbles at the waterline, although the remainder of the slope is obscured by vegetation. The downstream slope is fairly steep and consists of loose, gravelly soil with no grass cover. The slope is also heavily overgrown. A few large pieces of riprap have fallen or were dumped at the toe of the dike. No seepage was visible downstream, except that already described at the base of the left spillway sidewall.

- c. Appurtenant Structures. There is no low-level outlet at the spillway or dike. Water may bypass the spillway by entering the factory canal at the gate house. From there the flow may rejoin the Ware River channel by discharging over the canal spillway or through the low-level outlet at the canal.
- d. Reservoir Area. Light residential development occurs on the east side of the river, along River Street a railroad line runs parallel to the east bank of the river, from about 3 miles upstream of the Upper Dam, to approximately 1 mile downstream. Most of the land immediately west of the reservoir area is undeveloped woodland. There is some potential for future development on both sides of the river.
- e. Downstream Channel. The area immediately downstream of the dike is filled with brush and trees. The stream channel below the spillway is also lined with trees, with some growing in the floor of the channel. As shown on Photo No. 3 the left (east) side of the spillway channel is also partially obstructed by broken stone, which is presumably construction debris.

Both the main spillway and the canal spillway and outlet discharge into the Ware River channel. The earth slopes that form the sides of the river channel are moderately eroded. The floor of the channel is naturally lined with cobbles and boulders. There is a minor accumulation of tree branches and debris in the floor of the channel.

Vegetation and trees are growing on the floor and overhanging the banks of the channel.

About 1,000 feet downstream of the dam, the Pleasant Street bridge spans the Ware River channel. Under normal conditions there is no restriction to flow of discharge from the spillway. Water flows under the bridge in three 12 to 14-foot high archways (see Photo No. 14).

- 3.2 Evaluation. From the visual inspection it appears that the spillway is in fair condition. However, a thorough inspection of the rockfill dike was not possible due to the heavy growth of brush and trees. The stated deficiencies which must be corrected to assure the continued performance of this dam and measures to improve these conditions are outlined in Section 7.

SECTION 4

OPERATING AND MAINTENANCE

PROCEDURES

4.1 Operating Procedures

- a. General. There are no operating facilities at the main dam. According to the Plant Engineer, the standard procedure is to keep 2 to 3 gates open in the canal intake in order to maintain a constant flow in the factory canal. Water from the canal is used for process water, and for generating electrical power for plant operations.
- b. Warning System. There is no warning system in effect at this dam. As shown on Page B-12 in the Appendix, a high and low water level warning system was to have been installed at the Diamond International Plant in 1960. However, according to the Plant Engineer, that system was damaged by ice several years ago, and has not been replaced.

4.2 Maintenance Procedures

- a. General. The spillway is generally adequately maintained and the dike is poorly maintained. The Diamond International Corporation is responsible for maintenance of the facility. Annual inspections have been conducted in the past by personnel from the factory. Typical maintenance procedures have included repair of cracked or missing concrete and backfilling eroded areas on the dike.
- b. Operating Facilities. There are no operating facilities at the dam. Maintenance of the operating facilities at the factory canal consists of clearing debris from the canal intake. The operating condition of the slide gate mechanism in the canal gatehouse is checked periodically by the Owner.

- 4.3 Evaluation. There is a program for annual inspection and maintenance of the spillway and appurtenant structures. However, there is no program of regular technical inspections, a plan for surveillance of the embankment during and after periods of heavy rainfall, or an emergency warning system in effect. This is undesirable, considering that the dam is in the high hazard category. These programs should be implemented, as recommended in Section 7.3.

DIAMOND INTERNATIONAL CORPORATION UPPER DAM

SECTION 5

EVALUATION OF HYDRAULIC/HYDROLOGIC FEATURES

- 5.1 General. The Diamond International Upper Dam has a drainage area of 215.6 square miles (see Figure D-1, Drainage Area Map). The land is gently rolling to hilly, and generally undeveloped.

There are several dams upstream of the Upper Dam that provide additional storage within the watershed. The largest is the dam at Barre Falls Reservoir, located about 20 miles upstream of the Upper Dam. Storage provided by the Barre Falls Reservoir would reduce the peak flow to the Diamond International Dam.

The pond formed by the Upper Dam has a normal surface area of approximately 135 acres and normal storage capacity of 780 acre-feet at El 362.4. The maximum storage capacity is approximately 1,980 acre-feet at El 368. The surface area of the pond greatly increases with higher water elevations due to the potential for flooding in low-lying areas upstream of the dam. There is no low-level outlet at the dam.

- 5.2 Design Data. There are no hydraulic or hydrologic computations available for the design of the spillway at the Upper Dam.

- 5.3 Experience Data. A gaging station on the Ware River at Gibbs Crossing (about 5 miles upstream of the Upper Dam) recorded the following discharge rates during three major flooding events: March 1936: 11,200 cfs; September 1938: 22,700 cfs; August 1955: 12,200 cfs. The contributing watershed to the Gibbs Crossing gage is 199 square miles. An earthfill dike adjacent to the spillway was overtopped and washed out during heavy rains in March 1936. A second dike was breached during the floods of August 1955. In both cases the spillway was not damaged. There is no record of overtopping of the present dike, which was constructed in 1956. According to the Owner's representatives flooding has not been a problem since the flood control dam was built at Barre Falls in 1958. It should be noted, however, that there has not been a major flood in the watershed since 1955.

- 5.4 Test Flood Analysis. The Upper Dam at Diamond International has been classified in the "intermediate" size and "high" hazard categories. According to the Corps of Engineers guidelines, a test flood equal to the full PMF (Probable Maximum Flood) should be used to evaluate the capacity of the spillway.

DIAMOND INTERNATIONAL CORPORATION UPPER DAM

The PMF rate for the watershed to the Upper Dam was determined by comparing the calculated PMF rates for Barre Falls Dam and Conant Brook, both in the Ware River watershed.

These PMF values were plotted on the U.S. Army Corps of Engineers' guide curves for Maximum Probable Flood Peak Flow Rates (dated December 1977). As shown in Appendix D, both points fell slightly below the guide curve for rolling topography. The PMF rate for Diamond International Dam was then extrapolated from this curve, and was determined to be 670 cfs per square mile of drainage area.

Applying the full PMF rate to the 215.6 square mile drainage area results in a peak test flood inflow of 144,500 cfs from the watershed. The storage provided by Barre Falls Reservoir reduces the peak test flood inflow to 98,000 cfs at the full PMF rate. With adjustment for surcharge storage in the river channel, the peak test flood outflow from the Upper Dam was calculated to be 89,180 cfs (414 cfs per square mile).

By way of comparison, an alternative method for determining the PMF rate at the dam was used that considers the hydrologic differences that exist between the drainage areas above Barre Falls and Conant Brook, and the drainage area of the main Ware River Valley. Details of the computations are given on page D-4 of Appendix D. As a result of this alternate method, it was determined that a total PMF peak flow rate of 98,000 cfs appears reasonable for a Phase I analysis.

During the test flood, the pond level would rise to El 387.0, overtopping the dike and spillway by 19.0 and 24.6 feet respectively. The component of flow over the spillway would be 49,170 cfs, and over the dike would be 40,010 cfs. About 1,400 feet downstream of the dam, discharge would be constricted at a narrow point in the river channel, in the vicinity of the factory complex. This constriction would create a high backwater that would overtop the Pleasant Street Bridge, and result in an estimated tailwater level at the bridge at El 374.5.

The spillway has the capacity to discharge approximately 10 percent of the test flood outflow before the dike is overtopped. Although the capacity of the spillway is inadequate, the only means for significantly increasing the discharge from such a large drainage area would be to use the dike as an emergency spillway. Presently overtopping and flooding of the spillway and dike would be due more to the volume of runoff than to the limited capacity of the spillway.

DIAMOND INTERNATIONAL CORPORATION UPPER DAM

The effect of the one-half PMF flood was also calculated. As shown on page D-10 of the Appendix, the test flood outflow for the one-half PMF would be 46,200 cfs, or 214 cfs per square mile. The resulting flood pool would be at El 378, which would overtop the dike by 10 feet and the spillway by 15.6 feet. The resulting tailwater at the Pleasant Street bridge would reach approximate El 369.0.

- 5.5 Dam Failure Analysis. The peak discharge rate due to failure of the dam was calculated to be 22,400 cfs with the pond at El 368. This is compared to 9,210 cfs flowing over the spillway just prior to failure. Calculation of the peak discharge rate is based on a maximum head of 23.0 feet and an assumed 100-foot wide breach occurring in the spillway or dike. Failure of the dam would produce a downstream flood wave 18 feet deep at the Pleasant Street Bridge as compared to channel flow 9 feet deep prior to failure.

There are factory buildings and a parking lot located along the Ware River channel, east and west of Pleasant Street. The foundations of these structures are approximately 10 feet above the floor of the channel. Due to the configuration of the channel, little attenuation of the flood flow is expected. An assumed failure of the dam could produce a flood wave that would rise above the foundation level of the buildings and inundate the parking lot, resulting in the possible loss of more than a few lives and a significant amount of property damage. Accordingly, the dam has been placed in the "high" hazard category.

SECTION 6

STRUCTURAL STABILITY

- 6.1 Visual Observations. The evaluation of the structural stability of the Upper Dam at Diamond International Corporation is based on a review of previous inspection reports, and available drawings, and the visual inspection conducted on July 17, 1980.

As discussed in Section 3, Visual Inspection, the dam is in good condition. Leakage was observed at both abutments of the main spillway, but the water was clear. No settlement of the dike embankment was observed. There is a thick growth of trees and vegetation on both slopes of the dike.

- 6.2 Design and Construction Data. Construction of the Upper Dam was completed in 1918. Computations for design of the spillway and dike are not available.

Drawings showing the proposed or as-built construction of the dam are not available. One drawing dated 1955 prepared by the Harrison G. White Co. shows the proposed construction for the temporary dike east of the main spillway. The drawing shows the dike as an unzoned rockfill embankment founded on or close to bedrock. On the drawing rockfill is specified as large riprap filled with gravel and stone. The dike was designed to serve as an emergency spillway during periods of extremely high flow.

Specifications for construction of the spillway and dike are not available.

- 6.3 Post-Construction Changes. Since the original construction of the spillway, repairs and improvements have generally been limited to resurfacing concrete. There is no record of changes to the rockfill dike.

- 6.4 Seismic Stability. The dam is located in Seismic Zone No. 1, and in accordance with Corps of Engineers' guidelines does not warrant further seismic analysis.

SECTION 7

ASSESSMENT, RECOMMENDATIONS, AND REMEDIAL MEASURES

7.1 Dam Assessment

- a. Condition. As a result of the visual inspection, the review of available data, and limited information on operation and maintenance, the dam is considered to be in fair condition. The following deficiencies must be corrected to assure the continued performance of this dam: severe leakage through both spillway sidewalls; lack of low-level outlet at the dam; spalled concrete on the weir and sidewalls and accumulation of brush and trees on the dike.

The peak test flood (full PMF) outflow is estimated to be 89,180 cfs with the pond at El 387.0. The test flood would overtop the the dike by 19.0 feet. Hydraulic analyses indicate that the spillway can discharge 9,210 cfs or 10.3 percent of the test flood outflow before the dike is overtopped.

- b. Adequacy. The lack of detailed design and construction data did not allow for a definitive review. Therefore, the evaluation of this dam is based on a review of the available data, the visual inspection, past performance and engineering judgment.
- c. Urgency. The recommendations and remedial measures outlined below should be implemented by the Owner within 1 year after receipt of this Phase I Inspection Report.

7.2 Recommendations. It is recommended that the Owner employ a qualified registered engineer to:

- a. Evaluate the stability of the dike and spillway. This should include investigation of the leakage noted at the abutments of the spillway. The investigation should be conducted after the dike is cleared of brush.
- b. Develop procedures for clearing brush and trees to within 20 feet of the toe of the dike to permit further inspection. The engineer should include proper procedures for backfilling on the cleared areas.
- c. Perform a detailed hydrologic/hydraulic analysis to evaluate the discharge capability of the spillway.
- d. Design a low-level outlet as a means of lowering the reservoir during an emergency.

DIAMOND INTERNATIONAL CORPORATION UPPER DAM

The Owner should implement the recommendations of the Engineer.

7.3 Remedial Measures

a. Operating and Maintenance Procedures. It is recommended that the Owner accomplish the following:

- (1) Repair any spalled and deteriorated concrete on the main spillway.
- (2) Remove all brush, trees, debris and loose stone in the floor of the spillway discharge channel for a distance of 200 feet downstream of the dam.
- (3) Institute a definite plan for surveillance of the dike and spillway during and after periods of heavy rainfall and a plan to warn people in downstream areas in the event of an emergency at the dam.
- (4) Implement a systematic program of maintenance inspections. As a minimum, the inspection program should consist of a monthly inspection of the dam and appurtenances and be supplemented by additional inspections during and after severe storms. All repairs and maintenance should be undertaken in compliance with all applicable State regulations. The maintenance program should include removal of any debris caught on the spillway weir to prevent clogging of the spillway.
- (5) Institute a program of technical inspections of this dam to be conducted on an annual basis.

7.4 Alternatives. There are no practical alternatives to the above recommendations and remedial measures.

APPENDIX A
PERIODIC INSPECTION CHECKLIST

DIAMOND INTERNATIONAL CORPORATION UPPER DAM

PARTY ORGANIZATION

W.S. ELEV. 360.9 U.S. 347.4 D.N.S.

PERIODIC INSPECTION CHECK LIST

PROJECT DIAMOND INTERNATIONAL CORP. UPPER DAM DATE JULY 17, 1980

PROJECT FEATURE Main Spillway NAME S. Pierce

DISCIPLINE Geotechnical/Hydraulic NAME M. Nowak/L. Branagan

Note: u/s = upstream; d/s = downstream

AREA EVALUATED	CONDITION
<u>OUTLET WORKS - SPILLWAY WEIR, APPROACH AND DISCHARGE CHANNELS</u>	Concrete ogee weir and vertical stone masonry side walls, covered with gunite except at right cap wall at crest of weir.
a. Approach Channel	
General Condition	Clear; natural river bed
Loose Rock Overhanging Channel	None
Trees Overhanging Channel	None
Floor of Approach Channel	Submerged
b. Weir and Training Walls	Right wall continuous with canal dike retaining wall. Left wall free standing, next to rock fill dike.
General Condition of Concrete	Gunite in fair to good condition, two vertical cracks on weir, minor cracks, spalling on walls.
Rust or Staining	At base of left sidewall, at site of heavy leakage above bedrock outcrop
Spalling	Minor at toe of weir, exposing wire fabric; moderate at water line u/s
Any Visible Reinforcing	Wire fabric beneath gunite on weir.
Any Seepage or Efflorescence	Leaks at base of both side walls-clear at rt.wall, slight orange stain at lt.wall (above bedrock)
Drain Holes	None visible- 10-12" diam. pipe extending from toe of weir-no flow, & no controls.
c. Discharge Channel	
General Condition	Fair; bedrock outcrop at toe of weir-discharge channel narrower than weir width.
Loose Rock Overhanging Channel	Few large rocks in channel (construction debris)
Trees Overhanging Channel	Some
Floor of Channel	Many boulders, some bushes, small trees
Other Obstructions	None

PERIODIC INSPECTION CHECK LIST

PROJECT DIAMOND INTERNATIONAL CORP. UPPER DAM DATE July 17, 1980
 PROJECT FEATURE Rockfill Dike NAME S. Pierce
East of Main Spillway
 DISCIPLINE Geotechnical/Hydraulic NAME E. Greco

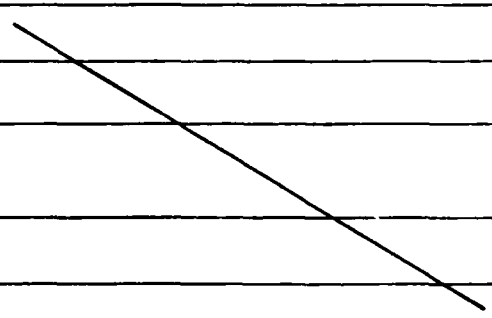
AREA EVALUATED	CONDITION
<u>DIKE EMBANKMENT</u>	Rockfill- extends east of main spillway
Crest Elevation	368.0
Current Pool Elevation	360.9
Maximum Impoundment to Date	Unknown
Surface Cracks	N/A
Pavement Condition	Crest clear-gravel, some weeds
Movement or Settlement of Crest	Not visible
Lateral Movement	None visible
Vertical Alignment	Flat
Horizontal Alignment	Straight
Condition at Abutment and at Concrete Structures	Right abutment: adjacent to side wall of main spillway Left abut: natural ground at RR tracks.
Indications of Movement of Structural Items on Slopes	None
Trespassing on Slopes	Light pole on upstream slope. Heavy vegetative cover (trees & bushes) on both slopes
Sloughing or Erosion of Slopes or Abutments	u/s - none visible d/s - loose, gravelly soil, no grass cover, very steep
Rock Slope Protection - Riprap Failures	Cobbles visible on slope
Unusual Movement or Cracking at or near Toes	None visible-heavy brush & tree cover at d/s slope
Unusual Embankment or Downstream Seepage	None visible at toe. Some leakage through base of left spillway side wall
Piping or Boils	None visible
Foundation Drainage Features	None visible
Toe Drains	None visible
Instrumentation System	None

PERIODIC INSPECTION CHECK LIST

PROJECT DIAMOND INTERNATIONAL CORP. UPPER DAM DATE July 17, 1980

PROJECT FEATURE Gatehouse on Canal NAME S. Pierce

DISCIPLINE Geotechnical/Hydraulic NAME M. Nowak

AREA EVALUATED	CONDITION
<u>OUTLET WORKS - CONTROL TOWER</u>	Wooden gatehouse with concrete foundation wall adjacent to roadway. Gates and floor supported by wooden angle supports and wooden piers.
a. Concrete and Structural	
General Condition	Very poor - holes in wooden roof and floor of structure.
Condition of Joints	N/A
Spalling	
Visible Reinforcing	
Rusting or Staining of Concrete	
Any Seepage or Efflorescence	
Joint Alignment	
Unusual Seepage or Leaks in Gate	Gates all submerged - not visible
Cracks	-
Rusting or Corrosion of Steel	-
b. Mechanical and Electrical	5 sluice gates operated by rack and pinion mechanism:
Air Vents	two gates open - appear to be operable. Remainder are rusted closed.
Float Wells	
Crane Hoist	-
Elevator	heavy accumulation of trash at u/s side of gates.
Hydraulic System	
Service Gates	
Emergency Gates	
Lightning Protection System	None
Emergency Power System	-
Wiring and Lighting System in Gate Chamber	One light bulb - wires carried from gatehouse to factory

Mr. George E. McDonald

-2-

February 19, 1958

SPECIFICATIONS: Item 11-Canal Spillway.

- 1-Jack capstone in place.
- 2-Drill holes down through each top capstone and half way through granite block below.
- 3-Insert 3/4" steel dowels in holes and grout in place.
- 4-Clean out open joints in gate structure and abutment walls by sandblasting and waterblasting.
- 5-Apply GUNITE to all open joints in gate structure and abutments sealing all open joints and consolidating the structure.

Thank you for your prompt attention.

Sincerely,



E. R. Gibbs
Maintenance Superintendent

BRE/eam

GENERAL PACKAGE

Division

THE DIAMOND MATCH COMPANY

Carry-Safe and Case Ace

GENERAL OFFICES
CHICAGO 11, U.S.A.

MOLDED EGG CARTONS

TEL. PALMER 930 - P. O. BOX 230
PALMER, MASSACHUSETTS
MAIL REPLY TO ABOVE ADDRESS

February 19, 1958

Mr. George H. McDonald
Tighe & Bond
Holyoke, Mass.

Dear Sir:

In regard to the letter from the Hampden County Commissioners dated December 31, 1957 relative to your inspection of our dams in Thorndike on the Ware River, we would like to submit the following specifications for your approval.

SCOPE OF WORK:

The work to be done on the main dam involves all sections of the spillway, starting 4' below the crest on the upstream face up over the crest and down the spillway to the toe of the dam.
The work to be done on the canal spillway involves the reinforcing of the old stone cap and the GUNITING of the Gate structure and both abutments.

SPECIFICATIONS - Item 1-Main Dam Spillway.

- 1-Remove all spalled disintegrated concrete down to good solid concrete by pneumatic chipping hammers.
- 2-Sandblast and waterblast the entire spillway area to be GUNITED.
- 3-Drill holes in sound concrete and insert 30" on centers, both directions and insert 1/4 x 2" expansion anchors.
- 4-Lay electrically welded wire mesh, size 4" x 4", #12 #12, over the entire spillway area attaching mesh to expansion anchors. All joints of mesh to lap by at least four (4) inches and securely tied to anchor bolts.
- 5-Immediately before GUNITING, waterblast entire area to remove dust, loose material and other forcing matter.
- 6-Apply GUNITITE in two or more coats, mixed in the proportions of one (1) part standard Portland cement and four and one-half (4-1/2) parts of clean, sharp and well graded sand to a thickness of 2-1/2". Screed to line and finish with a steel trowel.

CD Palmer

August 2, 1956

General Package Division
Diamond Match Company
P. O. Box 230
Palmer, Massachusetts

Gentlemen:

Recent inspections made at the site of your dam on Ware River, just upstream from your plant, in Thorndike show that repairs to the left abutment wall have been made with gunite by surfacing the dry side of the abutment and by grouting the central portion of the wall. It is apparent that you will probably begin the construction of the temporary dike in the near future and we wish to call you attention to the fact that this dike should be constructed of large stone and particular attention should be given to the placing of the stone so that the dike itself will be reasonably stable and act as a spillway even though it might be overtopped in an extreme flood.

Considerable leakage was noted at the base of the abutment wall near the upstream end of the wall. This leakage does not seem serious from a safety viewpoint and when the dike is constructed the stone construction will prevent the movement of any soil and thus the undermining of the wall or the dike itself. The material in the riverbed is extremely porous in nature and conditions are such that it would probably be difficult and expensive to control the leakage.

Periodic inspections will be made of the dike and if you have any question regarding construction procedure, please do not hesitate to contact the undersigned.

Very truly yours

GHM/cmb

George H. McDonnell
County Hydraulic Engineer

The Hon. The Board of County Commissioners
Springfield, Massachusetts

CD
Nov. 14, 1955

an upstream slope of three horizontal to one vertical. The width at the top of the dike as proposed will be 10 feet. The spaces between the large stones will be filled with smaller stones and the final voids will be filled in with gravel washed in place. As proposed in the specifications the dike will be constructed in 2 foot lifts and consequently a structure with a solid mass and few voids should be obtained.

The plan shows a transition section at a point 100 feet to 140 ft. easterly of the existing abutment. This transition section is on a 12% grade. The plan does not show how this area is to be protected from high water damage. It is recommended that the Owner be required to riprap this area with heavy stone approximately 2 feet in thickness. Each stone is to be approximately $1/5$ to $1/4$ cubic yard and this stone riprap is to be so placed as to prevent scour and erosion on this 12% grade as well as on the upstream and downstream faces of the area of the existing dike where velocity of flow will cause movement of small stones and gravel.

The proposed work also includes the repair of the easterly dam abutment.

Assuming then that the work proposed will be faithfully done in accordance with the plans and specifications filed and that the extra heavy riprapping and stone paving as recommended hereinabove will be included in the work, the undersigned recommends that the plan and specifications be approved.

Very truly yours

Tighe & Bond Inc.

George E. McDonnell
County Hydraulic Engineer

GHMcmb

COPY

CD

Nov. 14, 1955

The Hon. the Board of County Commissioners
Hampden County Court House
Springfield, Massachusetts

Gentlemen:

I have examined a plan and specification filed with Hampden County on Nov. 4, 1955. The Plan is entitled "Temporary Dike, General Package Division, The Diamond Match Company, Thorn-dike, Mass." drawing No. C-1701-5 and the specifications are en-titled "Specifications for the construction of a Temporary Dike, General Package Div., The Diamond Match Co., Palmer, Mass." The Plan and the Specifications were prepared by Harrison G. White Co., Engineers of Springfield, Massachusetts.

The proposed construction is on the Ware River at the upper dam formerly known as the Colgan-Sherman Dam and also re-ferred to in the past as "The Self Locking Carton Company Dam."

The existing dam was not damaged during the flood of August 1955. However, the earth dike to the left or East of the masonry dam was overtopped by the flood waters and washed out. Con-sequently, the Ware River now flows around the dam rather than over the masonry structure. The proposed dike is a temporary structure to be used to divert the flow of the Ware River into the proper channel and over the masonry dam. The dike will also serve as an upstream coffer dam for further planned construction which will in-clude the extension of the masonry dam to the East to form a perma-nent structure across the washed out area.

The proposed dike will be built of heavy rip-rap rather than of sand and gravel as in the past. The elevation of the top of the dike will be approximately 3 feet higher than the crest of the masonry dam and approximately 3 feet lower than the top of the washed out dike.

The dike will be sufficiently high to divert all normal as well as unusually heavy stream flows over the masonry dam. At times of exceptionally heavy stream flow the temporary dike will act as an emergency spillway. Consequently, the structure as proposed will provide greater ability for the passage of river flows than in the past.

The proposed construction is to include a rock filled dike with the downstream slope of two horizontal to one vertical and

SELF-LOCKING CARTON CO

Division of
GENERAL PACKAGE CORPORATION

Carry-Safe and Case Ace

TEL. PALMER 930 — P. O. BOX 230
MAIL REPLY TO ABOVE ADDRESS

MOLDED EGG CARTONS

PALMER, MASS.

July 14, 1955

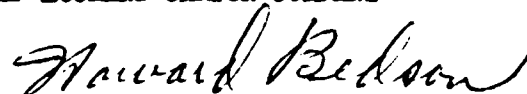
Commonwealth of Massachusetts
Office of the County Commissioners
37 Elm Street
Springfield, Mass.

Gentlemen:

With regard to your letter of July 6th concerning the hole in our earth dike as well as a small leak around the right end of our weir, we wish to advise that this work is completed as per your instructions.

Very truly yours,

SELF-LOCKING CARTON COMPANY



Howard C. Bedson
Superintendent

HB/cis

Copy of this letter mailed to
George H. McDonnell, County Hydraulic
Engineer, on July 18, 1955.

July 6, 1955

Self-Locking Carton Co.
P. O. Box 230
Palmer, Mass.

Gentlemen:

In accordance with the provisions of Chapter 253, Section 45 et seq. of the General Laws, Tercentenary Edition, relative to the inspection, condition and safety of the dams of Hampden County, you are hereby advised that your Upper Dam located on the Ware River in Palmer has been recently inspected by our Engineer, and your attention is called to the following conditions noted and recommendations made by him:

"There is a hole in the earth dike portion of the dam approximately 20 to 25 feet from the left stone abutment. This hole is visible on the top surface of the earth fill. The hole should be investigated, dug out if necessary, and then properly plugged with tight packed fill.

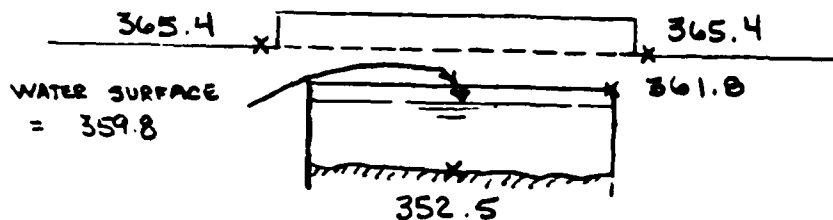
"There is a small leak around the right end of the small leakage weir dam that should be plugged so that all leakage flow passes over the measuring crest of the weir."

Will you kindly take steps to correct this situation by August 30th, 1955. Any further information concerning this matter which you may desire will be furnished by this office upon request. Our County Hydraulic Engineer will reinspect the dam following the completion of the repair work.

Very truly yours,

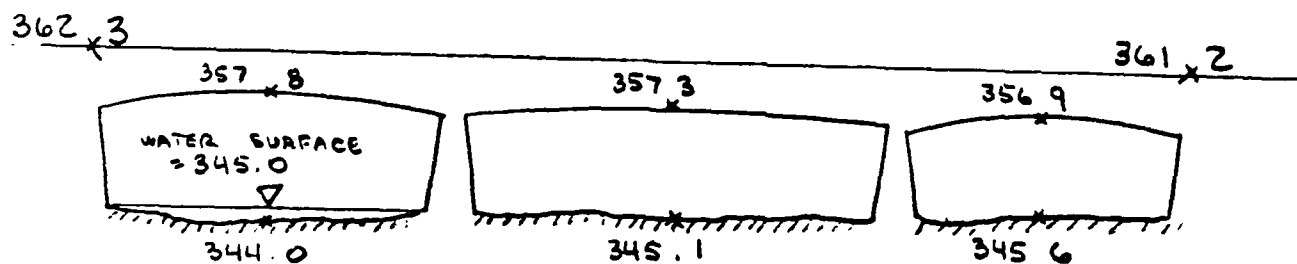
COUNTY COMMISSIONERS

By _____ Chairman



SECTION 6-6

CANAL BRIDGE
PLEASANT ST
SCALE 1 IN. = 20 FT

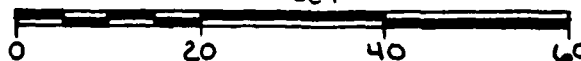


SECTION 7-7

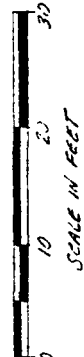
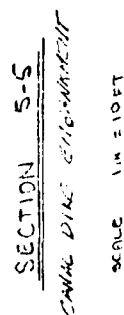
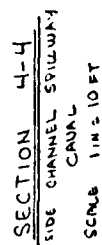
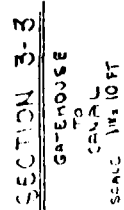
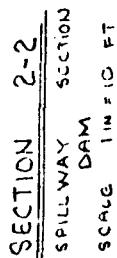
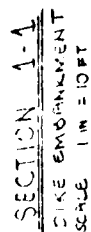
DOWNSTREAM BRIDGE
AT
PLEASANT ST.

SCALE 1 IN. = 20 FT.

SCALE
IN FEET



NETCALF & EDDY, INC. ENGINEERS BOSTON, MA.	U.S. ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS BALTIMORE, MD.
NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS	
DIAMOND INTERNATIONAL CORP. UPPER DAM	
FIGURE 8-3 ELEVATIONS OF DOWNSTREAM BRIDGES	
TRIBUTARY CHICOPEE RIVER	MASSACHUSETTS
SCALE: AS SHOWN	DATE: SEPTEMBER, 1980



WITNESS & CO., INC. 100 WEST 5TH ST. ST. LOUIS, MO.	I, J. ARNOLD, INSPECTOR OF NEW-REL. DAMS NATIONAL PROGRAM OF INSPECTION OF NEW-REL. DAMS DIAMOND INTERNATIONAL CORP. UNDER DAM FURNISH P-2 SECTIONS THROUGH DAM AND CANAL STRUCTURES TO MARYLAND CO. CORP. RIVER MASSACHUSETTS 1960
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APPENDIX B
PLANS OF DAM AND PREVIOUS
INSPECTION REPORTS

	<u>Page</u>
Figure B-1, Plan of Dam	B-1
Figure B-2, Sections through Dam, and Canal Structures	B-2
Figure B-3, Pleasant Street Bridges	B-3
Previous Inspection Reports (correspondence) Dated 1955 through 1960 by Hampden County Engineer's Office	B-4
Dated October 31, 1972 by Massachusetts Department of Public Works	B-13

PERIODIC INSPECTION CHECK LIST

PROJECT DIAMOND INTERNATIONAL CORP. UPPER DAM DATE July 17, 1980

PROJECT FEATURE Low-level Outlet
at Canal Spillway

NAME S. Pierce

DISCIPLINE Geotechnical/Hydraulic

NAME M. Nowak/L. Branagan

AREA EVALUATED	CONDITION
<u>OUTLET WORKS - INTAKE CHANNEL AND</u> <u>INTAKE STRUCTURE</u>	
a. Approach Channel	Submerged
Slope Conditions	
Bottom Conditions	
Rock Slides or Falls	
Log Boom	
Debris	
Condition of Concrete Lining	
Drains or Weep Holes	
b. Intake Structure	See below
Condition of Concrete	
Stop Logs and Slots	

u/s: Stone masonry headwall coated with gunite, tied and bolted with metal straps. Gunite deteriorating on top.

d/s: Joint spacing approx. 1" on vertical joints between stone blocks
No gunite on lower half of headwall
Seepage through horizontal joints
Heavy leakage through crown of outlet

Outlet: Stone box conduit with sluice gate
Wooden gate closed, no visible leaks through gate
Rack and pinion mechanism for operating gate (not tested)
may not be operable.

Discharges into same channel with canal spillway, which flows to Ware River channel.

PERIODIC INSPECTION CHECK LIST

PROJECT DIAMOND INTERNATIONAL CORP. UPPER DAM DATE July 17, 1980
 PROJECT FEATURE Canal Spillway NAME S. Pierce
 DISCIPLINE Geotechnical/Hydraulic NAME M. Nowak/L. Branagan

AREA EVALUATED	CONDITION
<u>OUTLET WORKS - SPILLWAY WEIR, APPROACH AND DISCHARGE CHANNELS</u>	Canal spillway discharges from canal to Ware River. Right (south) wall: gunite over stone masonry left (north) wall: vertical stone wall of outlet.
a. Approach Channel	
General Condition	Fair - channel clear
Loose Rock Overhanging Channel	None
Trees Overhanging Channel	None
Floor of Approach Channel	Submerged, not visible
b. Weir* and Training Walls	Granite cut blocks with thin gunite coat; some weeds growing through joints. Gunite is cracked in places, walls mostly submerged upstream
General Condition of Concrete	None visible
Rust or Staining	None visible
Spalling	Gunite chipped or eroded on d/s side left wall shows worst spalling
Any Visible Reinforcing	None
Any Seepage or Efflorescence	Left sidewall: severe spalling of gunite; efflorescence
Drain Holes	None visible
c. Discharge Channel	
General Condition (discharge channel)	Fair condition
Loose Rock Overhanging Channel	Few blocks have fallen from left side wall of channel
Trees Overhanging Channel	Several, up to 6-inch diameter
Floor of Channel	Littered with boulders, stone blocks, some debris.
Other Obstructions	Channel narrows before entering river bushes growing on "spit" at end of channel

*b. Weir - stone masonry, narrow crested weir
 8 bays of flashboards with iron supports. Boards can be removed by iron pins - all metal rusted, boards starting to rot; one set missing.
 Flashboards leaking at crest; bridge looks insecure.

PERIODIC INSPECTION CHECK LIST

PROJECT DIAMOND INTERNATIONAL CORP. UPPER DAM DATE July 17, 1980

PROJECT FEATURE Canal leading from
Canal gatehouse to factory.

NAME S. Pierce

DISCIPLINE Geotechnical/Hydraulic

NAME M. Nowak

AREA EVALUATED	CONDITION
<u>OUTLET WORKS - OUTLET STRUCTURE AND OUTLET CHANNEL</u>	Vertical sidewalls both u/s and d/s of gatehouse constructed of concrete and gunited stone in good condition.
General Condition of Concrete	
Rust or Staining	Minor rust/discoloration at high water mark.
Spalling	None
Erosion or Cavitation	None. Minor growth of moss in upper joints, where there is no gunite.
Visible Reinforcing	None
Any Seepage or Efflorescence	Minor efflorescence
Condition at Joints	Covered with gunite
Drain Holes	None visible
Channel	Canal leading to factory complex
Loose Rock or Trees Over- hanging Channel	Few bushes, no rock
Condition of Discharge Channel	Good

1. D/s of gatehouse - canal separated from Ware River by earth dike.
2. Canal flows under Pleasant Street, to factory complex. Two intakes permit flow to turbines, and for process water.
3. All water discharged to river below factory.

CL Palmer
Nov. 3, 1958

Diamond Gardner Corp.
Palmer, Mass.

Att: Howard Bedson, Plant Engineer

Dear Mr. Bedson:

I have received a copy of your letter written to the County Commissioners of Hampden County dated Sept. 23, 1958, pertaining to the work being done at your dam and canal near your plant in Palmer.

An inspection of your dams and related facilities was made by the undersigned on Monday, October 13, 1958. At that time the repair work to your Upper Dam and to the canal and spillway was examined. At the Lower Dam the work of clearing all brush and tree growth from the dike had been completed. Our report to the County Commissioners on your dams and related facilities is as follows:

"Self-Locking Carton Co. Upper Dam This dam was found to be in excellent condition. Repairs to the overflow structure have been recently completed and all eroded concrete has been well covered and protected with a new layer of concrete applied with air guns. The canal wall downstream of the dam and the canal spillway were found to be in good condition. A small amount of leakage is occurring under the right abutment of the main dam. This leakage emerges at the toe. This is not serious.

The left stone abutment of the main dam where settlement and cracking was previously noted is still in the same condition but not dangerous.

The rock dike to the left of this dam constructed to close the breach caused by the flood of August, 1955 is in good condition.

Self-Locking Carton Co. Lower Dam This dam was found to be in satisfactory condition. All tree and brush growth on the canal dike has been cut down as recommended. An excellent job of removing this growth has been done. The dike was found to be in satisfactory condition."

DIAMOND NATIONAL CORPORATION



GROWING FOR THE FUTURE

MOLDED-PACKAGING DIVISION

PALMER MASS. PLANT

GENERAL OFFICES

122 E. 42ND ST., NEW YORK 17, N. Y.

TEL. PALMER 930 - P. O. BOX 230
PALMER, MASSACHUSETTS
MAIL REPLY TO ABOVE ADDRESS

October 6, 1960

Board of County Commissioners
County of Hampden
37 Elm Street
Springfield, Massachusetts

SUBJECT: INSPECTION REPORT ON #1 MILL DAM

Gentlemen:

We wish to acknowledge receipt of your inspection report covering our lower dam in the Ware River, commonly referred to as #1 Mill dam.

The surface washouts on the dike at this location were repaired on October 6, 1960. Seventy eight yards of gravel were dumped and leveled by a local contractor, bringing the dike back to its original grade.

We are also following your recommendation regarding a change in operating procedure by installing a high and low water level warning system in the canals at both #1 and #2 Mills. This warning system will be connected to a panel in a constantly attended area in #2 Mill, and will give the operating personnel an audible as well as visual warning in the event of an abnormal water level in either canal. This system should be installed and in operation no later than November 1, 1960.

The comments of your Hydraulic Engineer, Mr. McDonnell, regarding the dike and our operating procedures are most certainly welcome and appropriate. We thank you for bringing them to our attention.

Very truly yours,

DIAMOND NATIONAL CORPORATION

Howard C. Bedson
Plant Manager

HCB:ark

cc: Mr. McDonnell

copy of this letter sent to
Mr. G.H. McDonnell on Oct. 11, 1960.

OK
FILE ✓

INSPECTION REPORT - DAME AND RESERVOIRS

1. Location: City/Town PALMER Dam No. 3-7-227-13
Name of Dam DIAMOND NATIONAL CORP. UPPER DAM Inspected by THOMAS M. CANNON & M...
Date of Inspection 10-31-72

2. Owner/s: per: Assessors _____ Prev. Inspection ✓
Reg. of Deeds _____ Pers. Contact _____

1. DIAMOND NATIONAL CORP. THORNHILL - PALMER, MASS.
Name St. & No. City/Town State Tel. No.
2. _____
Name St. & No. City/Town State Tel. No.
3. _____
Name St. & No. City/Town State Tel. No.

3. Caretaker (if any) e.g. superintendant, plant manager, appointed by absentee owner, appointed by multi owners.

Name: _____ St. & No. _____
City/Town: _____ States: _____ Tel. No. _____

4. No. of Pictures taken 1

5. Degree of Hazard: (if dam should fail completely)*

1. Minor _____ 2. Moderate ✓ _____
3. Severe _____ 4. Disastrous _____

*This rating may change as land use changes (future development)

6. Outlet Control: Automatic _____ Manual ✓ _____
Operative ✓ Yes; _____ No.

Comments:

7. Upstream Face of Dam: Conditions

1. Good ✓ 2. Minor Repairs _____
3. Major Repairs _____ 4. Urgent Repairs _____

Comments:

8. Downstream Face of Dam:

Condition: 1. Good ✓

2. Minor Repairs _____

3. Major Repairs _____

4. Urgent Repairs _____

Comments:

9. Emergency Spillway:

Condition: 1. Good _____

2. Minor Repairs _____

3. Major Repairs _____

4. Urgent Repairs _____

Comments:

10. Water Level at time of inspection: 6 ft. above _____ below ✓

top of dam ✓ principal spillway _____

other _____

11. Summary of Deficiencies Noted:

Growth (Trees and Brush) on Embankment YES

Animal Burrows and Washouts NONE

Damage to slopes or top of dam NONE

Cracked or Damaged Masonry NONE

Evidence of Seepage YES

Evidence of Piping NONE

Erosion NONE

Leaks NONE

Trash and/or debris impeding flow NONE

Clogged or blocked spillway NONE

Other _____

12. Remarks and Recommendations: (Fully Explain)

THE CANAL DIKE IS IN SATISFACTORY CONDITION. THE SPILLWAY WAS OPERATING AT THE TIME OF INSPECTION, BOTH THE DIKE AND THE SPILLWAY WERE NOTED TO BE O.K.

THE MAIN DAM WAS IN VERY GOOD CONDITION, NO FLASHBOARDS WERE ON THE CREST AND WATER WAS OVERFLOWING THIS SPILLWAY DAM.

BOTH ABUTMENTS WERE IN EXCELLENT CONDITION. THE CURBING IS WELL MAINTAINED AND IS STANDING UP SATISFACTORILY.

THERE IS HARDLY ANY EVIDENCE OF WEAR ON THE MASONRY OF THE DAM.

THE LEFT STONE FILLED PORTION OF DAM BETWEEN THE LEFT SIDE OF THE MAIN SPILLWAY AND THE RAILROAD TRACKS IS SATISFACTORY. EVIDENCE OF SEEPAGE THROUGH THIS FILL AND UNDER THE LEFT ABUTMENT WAS OBSERVED AND DOESN'T APPEAR TO BE SERIOUS. THIS SEEPAGE HAS BEEN ^{indicated by water seepage} ~~SAID TO BE CAUSED BY THE RAILROAD~~ ^{RECOMMEND TREES + BRUSH} ~~PLANTED TO STOP THE SEEPAGE~~ ^{BEHIND THE DAM.}

IN THE OPINION OF THE INSPECTOR, THE DAM AND ALL ITS RELATED FACILITIES ARE IN VERY GOOD CONDITION, AND THE STRUCTURES SAFE.

13. Overall Condition:

1. Safe ✓
2. Minor repairs needed _____
3. Conditionally safe - major repairs needed _____
4. Unsafe _____
5. Reservoir impoundment no longer exists (explain)
Recommend removal from inspection list _____

DESCRIPTION OF DAM

DISTRICT 3Submitted by THOMAS M. KELLEY, JR. Dam No. 3-7-327-13Date 10-31-72City/Town PalmerName of Dam SELFLOCKING CARTON CO.
PALMER NATIONAL CORP.
UPPER DAM1. Location: Topo Sheet No. 15B

Provide 8½" x 11" in clear copy of topo map with location of Dam clearly indicated.

2. Year built: _____ Year/s of subsequent repairs _____

3. Purpose of Dam: Water Supply ✓ Recreational ✓

Irrigation _____ Other _____

4. Drainage Area: W. RIVER sq. mi. _____ acres5. Normal Ponding Area: UNKNOWN acres; Ave. depth _____

Impoundments: _____ gals; _____ acre ft.

6. No. and type of dwellings located adjacent to pond or reservoir

NONE i.e. summer homes, etc. _____7. Dimensions of Dam: Length 500± Max. Height 21'Slopes: Upstream Face VERTICAL TO 3:1 VARIESDownstream Face VERTICAL TO 2:1 SLOPE VARIESWidth across top 14'

8. Classification of Dam by Materials:

Earth ✓ Conc. Masonry ✓ Stone Masonry ✓

Timber _____ Rockfill _____ Other _____

9. A. Description of present land usage downstream of dam:

80 % rural; 20 % urban.B. Is there a storage area or flood plain downstream of dam which could accomodate the impoundment in the event of a complete dam failure? yes ✓ no _____.

DAM NO. 3-7-227-13

10. Risk to life and property in event of complete failure.

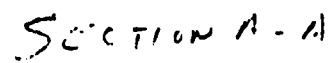
No. of people NONE .
No. of homes NONE .
No. of Businesses NONE .
No. of industries NONE . Type _____
No. of utilities NONE . Type _____
Railroads NONE .
Other dams 3-7-227-14 .
Other NONE .

11. Attach Sketch of dam to this form showing section and plan.
on 8½" x 11" sheet.

12. HOW TO LOCATE: FROM THE INTERSECTION OF CHURCH & HILL ST'S, 0.1 MILE
ON HILL ST. TO GATE HOUSE ON RT.

Palmer

Stamps
River



APPENDIX C

PHOTOGRAPHS

Note: Location and direction of photographs shown on Figure B-1
in Appendix B.

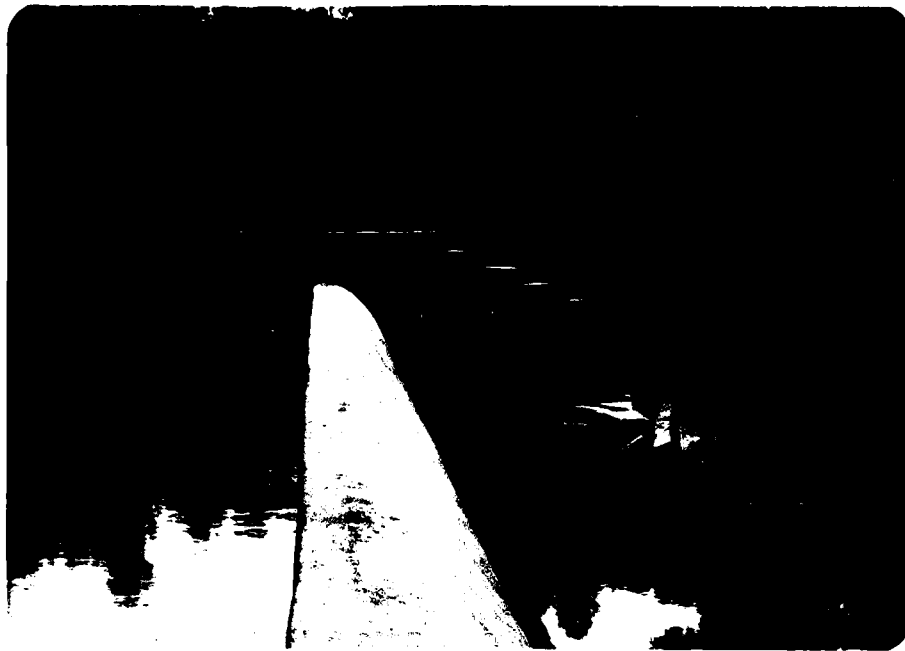
DIAMOND INTERNATIONAL CORPORATION UPPER DAM



NO. 1 MAIN SPILLWAY AND RIGHT SIDEWALL



**NO. 2 LEAKAGE AT TOE OF SPILLWAY AND RIGHT
SIDEWALL**



NO. 3 MAIN SPILLWAY AND LEFT SIDEWALL



**NO. 4 LEAKAGE AT BASE OF LEFT SIDEWALL, ABOVE
BEDROCK**



NO. 5 TOP OF DIKE ADJACENT TO MAIN SPILLWAY



NO. 6 UPSTREAM SLOPE OF DIKE



NO. 7 UPSTREAM SIDE OF CANAL GATEHOUSE



NO. 8 GATE MECHANISM INSIDE CANAL GATEHOUSE

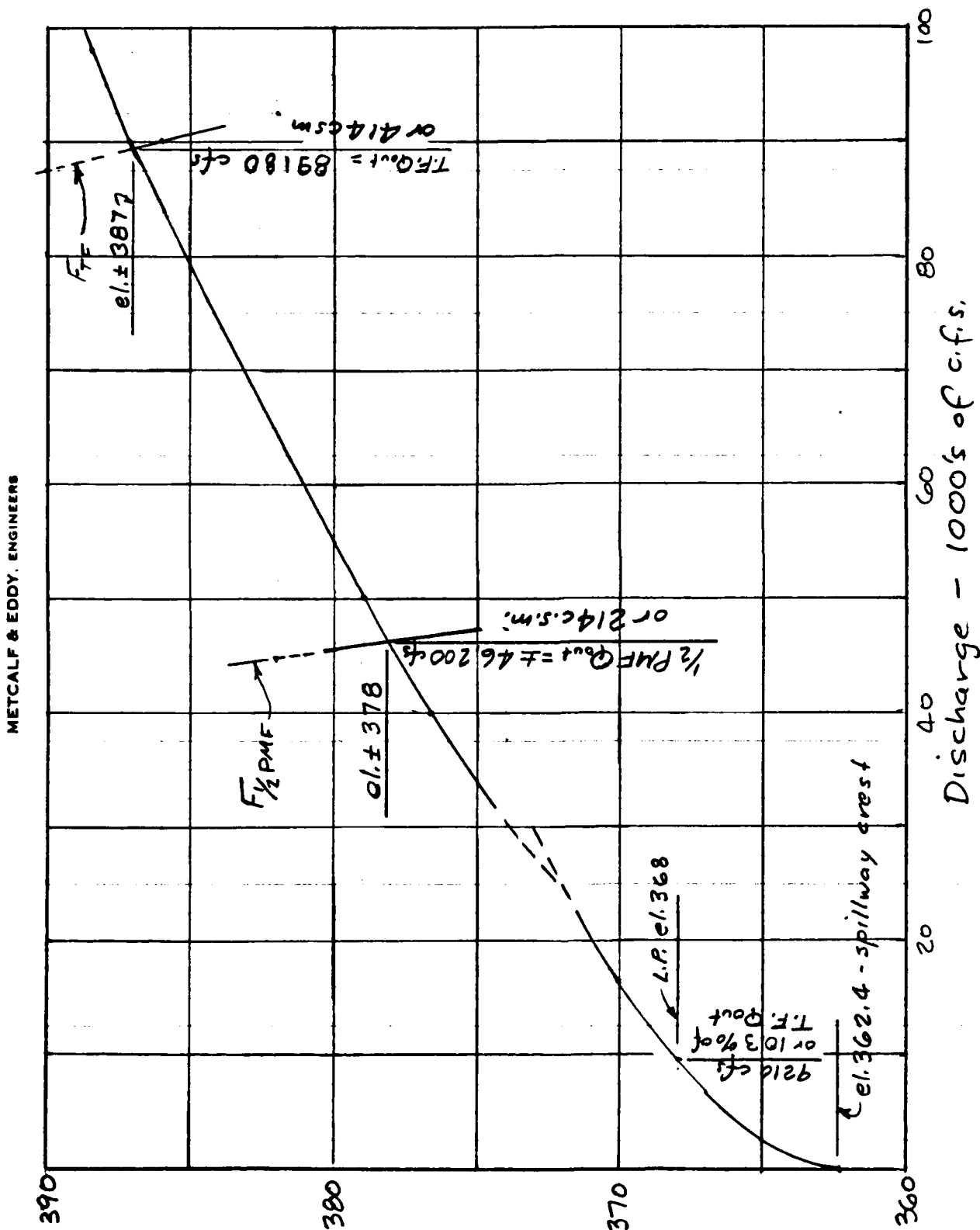


NO. 9 CANAL LEADING TO FACTORY COMPLEX



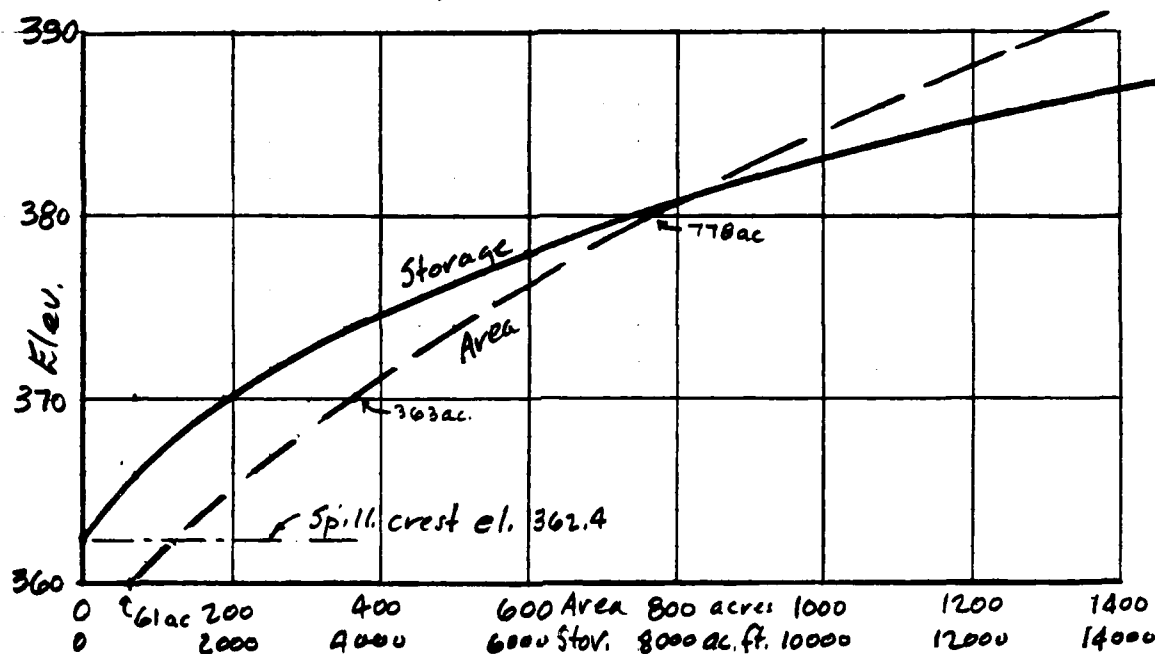
NO. 10 CANAL AT FACTORY COMPLEX

VI Discharge & Storage Function vs Res. Elevation



⑤ Storage & Storage Function

A - Upstream Areas & Storage Volume



B - Storage & Storage Function

For Test Flood : $Q_{out} = Q_{in} \left[1 - \frac{S}{R} \right] = 98000 - 5158 S$

For $\frac{1}{2}$ PMF : $Q_{out} = 49000 - 5158 S$

R = in. of rain in storm ; S = res. storage in terms of inches on drainage area. Use net drainage area, below Barre Res, of 160.6 mi²

Elev	Area	Incr. Vol.	Σ Vol.	S	TF Q_{out}	$\frac{1}{2}$ PMF Q_{out}
362.4	135		0	0	98000	49000
		666				
366	235		666	.0778	97600	48700
		1196				
370	363		1862	.2174	96900	48200
		1746				
374	510		3608	.4212	95800	47400
		2380				
378	680		5988	.6991	94400	46300
		3100				
382	870		9088	1.0610	92500	44900
		3890				
386	1075		12978	1.5152	90200	41200
		4790				
390	1320		17768	2.0744	87300	38300

IV Dam Discharge - with Tailwater - Cont.

3 - Dnstr. $Q = 90000$ cfs ; $d_1 = 17.3'$, $d_2 = 11.5'$

Upstr. El.	h_1	d_1/h_1	n_1	Q_1	h_2	d_2/h_2	n_2	Q_2	ΣQ
387	24.6	.703	.785	49170	19.8	.612	.840	40010	89180
387.1	24.7	.700	.787	49660	18.9	.608	.842	40470	90130

Use upstr. res. el. 387.1 for 90000 cfs

4 - Dnstr. $Q = 98000$ cfs ; $d_1 = 18.4'$; $d_2 = 12.6'$

Upstr. El.	h_1	d_1/h_1	n_1	Q_1	h_2	d_2/h_2	n_2	Q_2	ΣQ
388	25.6	.719	.774	51110	19.8	.636	.826	42160	93270
388.5	26.1	.705	.784	53630	20.3	.621	.836	44570	98200
388.4	26.0	.708	.782	53120	20.2	.624	.834	44080	97200

Use upstr. res. el. 388.5 for 98000 cfs

④ Dam Discharge - with Tailwater

Ref.: Davis, "Hnbk. of Appl. Hydr." - pg 1224 - Table 11

$Q_1 = 3.33 L_1 n_1^{1.5} h_1^{1.5}$; $n = f d/h$, h = upstr. depth above crest,
 d = dnstr. depth above crest; n from Table 11

Spillway - 174' @ el. 362.4, Dam crest - 250' @ el. ± 368.2

For dam crest, $Q_2 = 2.55 L_2 n_2^{1.5} h_2^{1.5}$

1 - 40000 cfs, $d_1 = 8.1'$, $d_2 = 2.3'$

Upstr. El.	h_1	d_1/h_1	n_1	Q_1	h_2	d_2/h_2	n_2	Q_2	ΣQ
377.4	15.0	0.54	.875	27550	9.2	0.25	.972	17050	44600
376.9	14.5	.558	.867	25830	8.7	.264	.969	15600	41430
→ 376.7	14.3	.566	.858	24900	8.5	.270	.967	15020	39920 ←

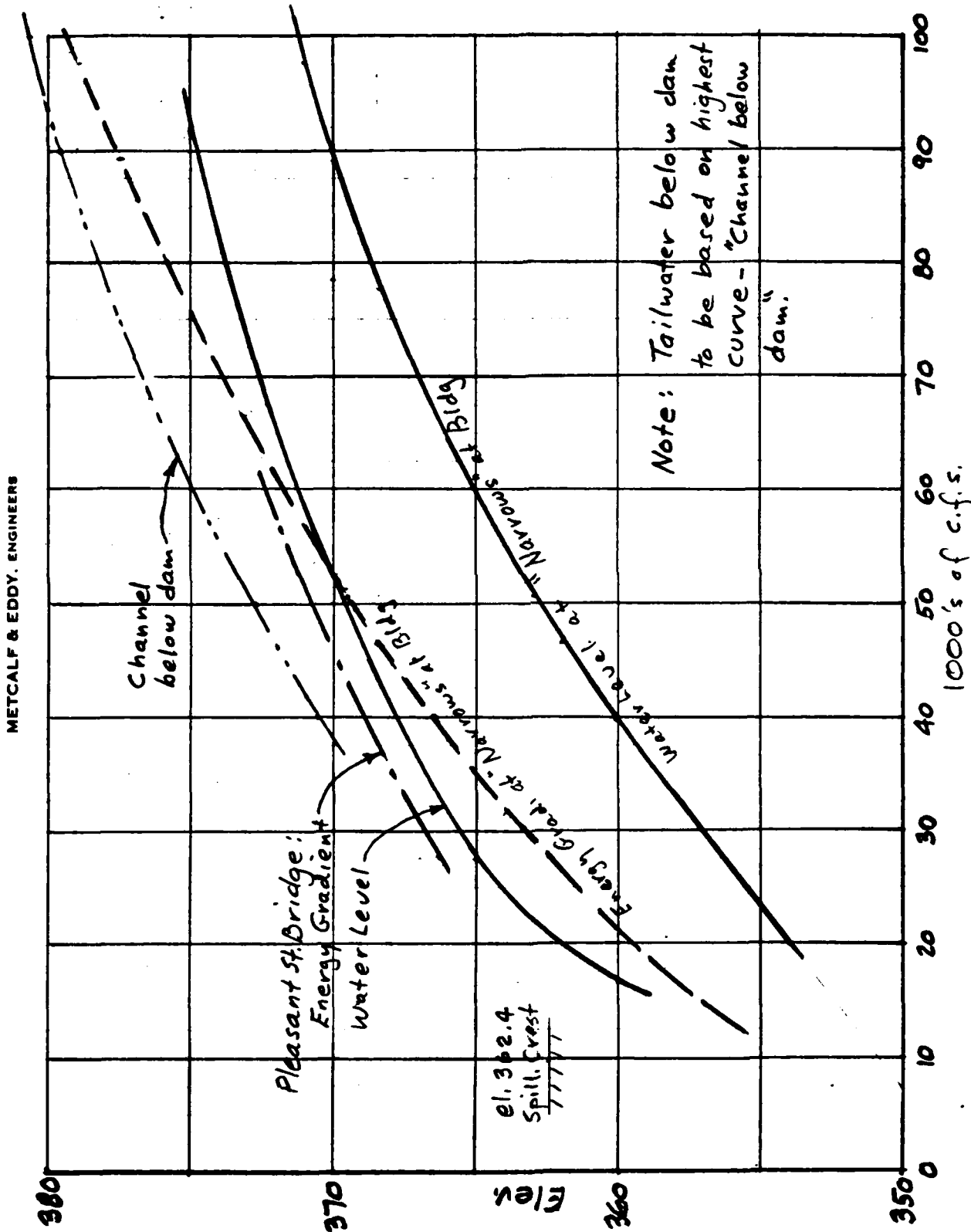
Upstr. res. el. 376.7 for 40,000 cfs

2 - 50000 cfs, $d_1 = 10.4'$, $d_2 = 4.6'$

Upstr. El.	h_1	d_1/h_1	n_1	Q_1	h_2	d_2/h_2	n_2	Q_2	ΣQ
379.0	16.6	.626	.832	29740	10.8	.426	.920	19970	49710 (-290)
379.1	16.7	.623	.834	30120	10.9	.422	.921	20280	50400 (+400)

Upstr. res. el. 379.0 for 50,000 cfs

III Est. Tailwaters & Test Flood Disch. Elev.

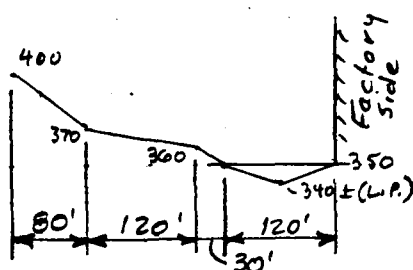


II Discharge Relations - Continued

4- Backwater from Narrows at South Cor. Factory

Assume critical depth at narrows:

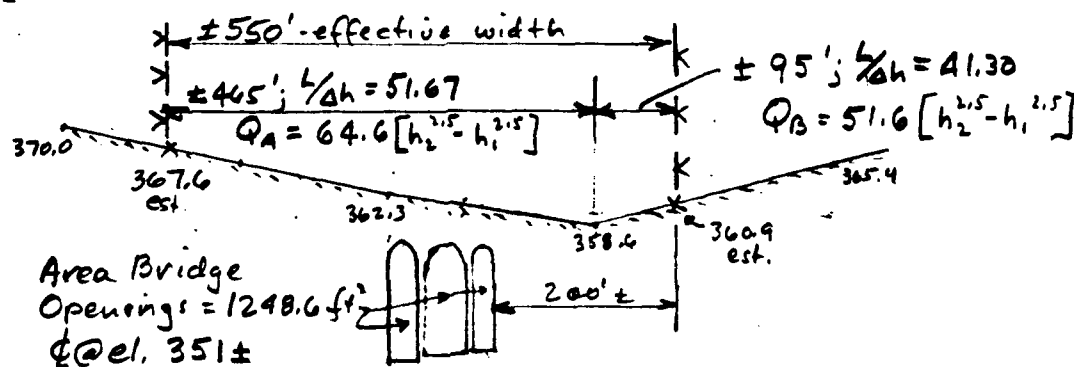
$$Q_c = \left(g \frac{A^3}{B} \right)^{1/2} \quad A = \text{Area}, B = \text{Top Width of Flow}$$



Water El. @ Narrows	A	B	Q_c	En. Grade
350	600	120	7600	352.5
360	1950	150	39900	366.5
370	4050	270	89000	377.5
362	2274	174	46600	368.5
363	2454	186	50600	369.6
372	4595	275.3	106,500	380.3
371	4321	272.7	97,600	378.9

5- Backwater from Pleasant St. Bridge Section (No tail water)

$$\left[\text{For sloped weir } (C_d = 0.585) : Q = 1.25 \frac{L}{\Delta h} [h_2^{2.5} - h_1^{2.5}] ; \Delta h = h_2 - h_1 \right]$$



$$\text{For Orifices: } Q_c = 0.61 A \sqrt{2g h_c} = 6112 \sqrt{h} \quad [h = \text{diff. in water el.}]$$

Note: h_c based on Δh using hydraulic level from Narrows.

Water Eleu	360	365	370	375	376
h_{21}	1.4	6.4	11.4	16.4	17.4
h_{11}	0	0	2.4	7.4	8.4
Q_A	150	6690	27770	60740	68370
h_{20}	1.4	6.4	11.4	16.4	17.4
h_{10}	0	4.1	9.1	14.1	15.1
Q_B	120	3590	9750	17680	19450
h_c	7 ±	6 ±	6 ±	5 ±	5 ±
Q_c	16170	17280	14970	13670	13670
ΣQ_s	16440	27570	52490	92090	101490
(Ave) h_v	2.31	1.31	1.18	1.54	1.64

(II) Discharge Relations

1- Spillway (no tailwater effect)

$\pm 174'$ long, rounded crest ; $Q \approx 174(4) H_1^{1.5} = 695 H_1^{1.5}$
 Crest elev. 362.4

Water El.	365	370	375	380	385	390	368
Q_1	2910	14560	31080	51320	74670	100,770	9210

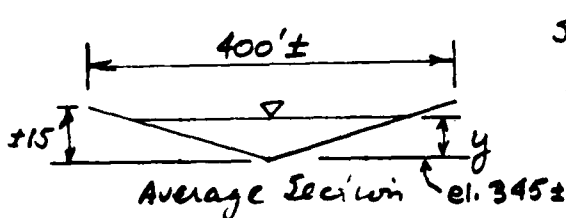
2- Dam Crest Flow (no tailwater effect)

$\pm 150' @ \text{el. } 368.0 ; (\pm 100) + (\pm 65) @ \text{el. } 368.4$
 $Q = 2.55 H_1^{1.5}$

Water El.	370	375	380	385	390	393	394
Q_A	1080	7080	15900	26810	39470	47810	50710
Q_B	850	7130	16620	28460	42240	51340	54500

ΣQ_2	1,930	14,210	32,520	55,270	81,710	99,150	105,210
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3- Channel Loss - Dam to Pleas. St. Bridge



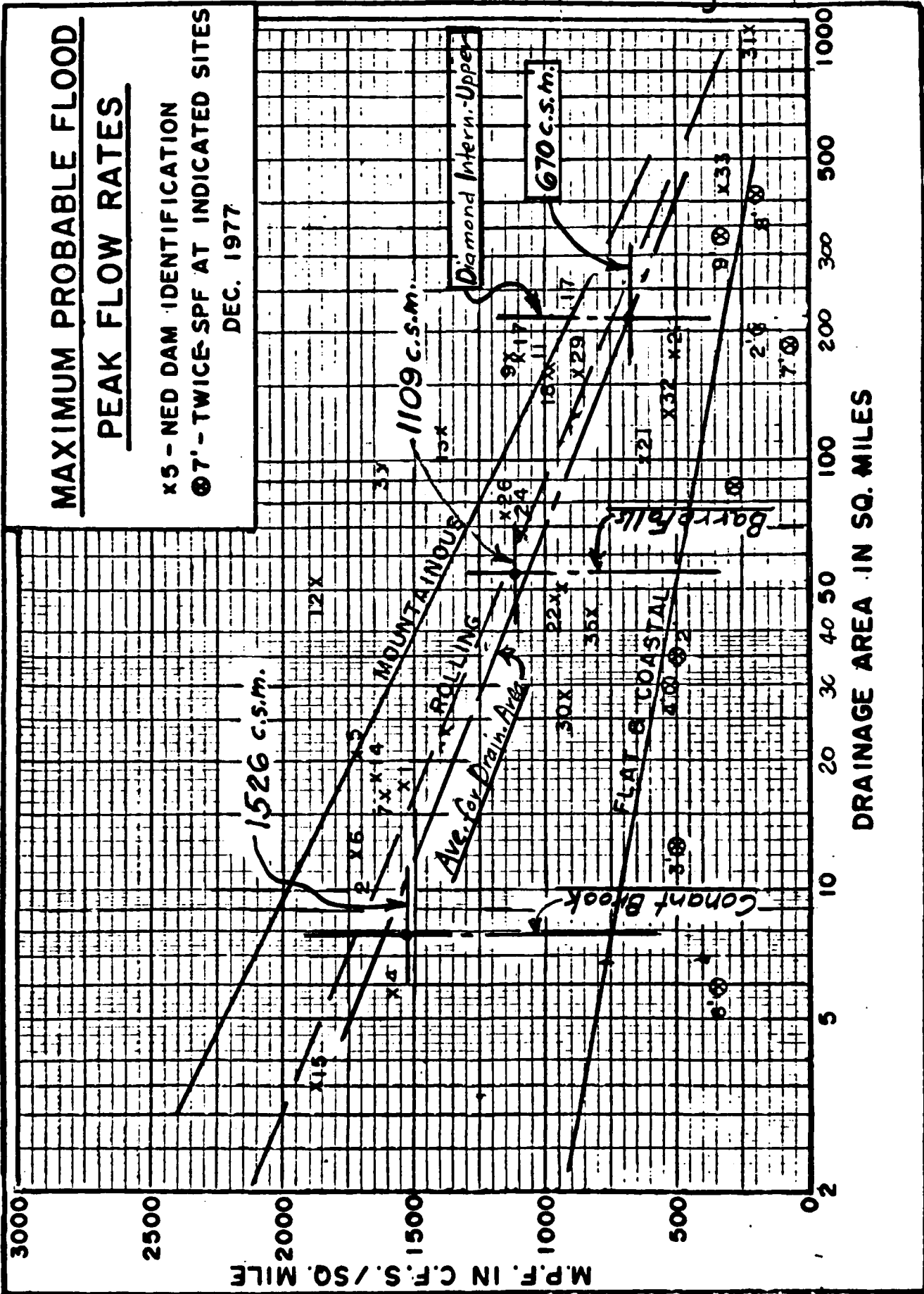
$$S = \frac{2.4}{1100} = .002182; n = .08, R \approx \frac{1}{2} y$$

$$V = 0.548 y^{2/3}; A = 13.33 y^2, Q = 7.307 y^{8/3}$$

$Q = 40,000$	50,000	90,000	198,000	200,000
$y = 25.2$	27.4	34.2	35.3	19.5
$V = 4.71 \text{ fps}$	4.98 fps	5.77	5.90	3.96
$h_v = 0.35'$	0.38'	0.52	0.54	0.24
$\pm \text{El} = 370.5$	372.8	379.7	380.8	364.7

MAXIMUM PROBABLE FLOOD PEAK FLOW RATES

X 5 - NED DAM IDENTIFICATION
 7' - TWICE-SPF AT INDICATED SITES
 DEC. 1977



d. - Alternative Determination of PMF

The PMF of Section "C" is based on the assumption that the entire drainage area above Diamond International is hydrologically similar to that above Barre Falls Dam and Conant Brook Dam, and that the maximum possible flow rate reduction will be effected at Barre Falls Dam.

The Wave River between Barre Falls and the Diamond Inter. Upper Dam has a slope of 0.25% and would develop considerable channel storage during high runoff, resulting in lower peak flows downstream. Coincident discharge from Barre Falls Dam would be on the rising part of the discharge hydrograph - below the peak for the test storm.

Using the Max. Prob. Flood Curve used in Section "C" for 160.6 sq. miles, and a point half way between "Flat & Coastal" and "Ave. for Drain. Area", the M.P.F. is ± 560 cfs/mi² for 160.6 sq. miles. This point is taken as an average between runoff rates from the extremes of the D.A. (Barre Falls & Conant Brook) and the main valley which might be characterized by "Flat & Coastal" - or even lower.

The PMF peak for the area bet. Barre Falls & Diam. Int. is then:

$$160.6 (560) = 89936 \approx 90,000 \text{ cfs.}$$

A coincident flow from Barre Falls of 8000 cfs is over half of the Barre Falls Dam - Spillway Design Flood-peak discharge, of 14,800 cfs (1973 studies). The Barre Falls Dam produces a lag of ± 6 hours between peak inflow and peak outflow.

A total PMF peak flow rate of 98,000 cfs appears reasonable - and sufficiently conservative for a Phase I analysis

Note: C. of E. values used above are taken from the Master Manual of Water Control, Appendix G, Chicopee River Watershed, January 1979

I Test Flood

a - Category of Test Flood

Dam size : Intermed. ; Hazard Cat. : HIGH
 Test Flood : Full PMF

b - Available Data

Drainage Area: 138,000 ac. or 215.6 mi²

C. of E. study for Barre Falls Dam (as reviewed in 1967) has 61,000 peak inflow from 55 mi², reduced to 14,500 cfs outflow. Rain is 20.1 in. in 3 hr. - full PMP, Inflow is 1109 c.s.m.

Also, for Conant Brook Dam the PMF inflow is 11900 cfs from 7.8 mi² for 1526 csm

c - Diamond Inter. Upper PMF

The PMF points for Barre Falls & Conant Brook were plotted on the Max. Prob Flood curves provided by the C. of E. Both were slightly below "Rolling". A radial line, similar to the other curves, was plotted by these points. The PMF for Diam. Int., with a drainage area of 215.6 mi², was taken from this line as 670 c.s.m. (see attached print)

Peak Full PMF without Barre Falls = $670(215.6) = 144500 \text{ cfs}$

Reduction due to Barre Falls Res. = -46500

(Net) Full PMF at Diamond Inter. Upper = $98,000 \text{ cfs}$

\therefore Test Flood = Full PMF = 98,000 cfs.

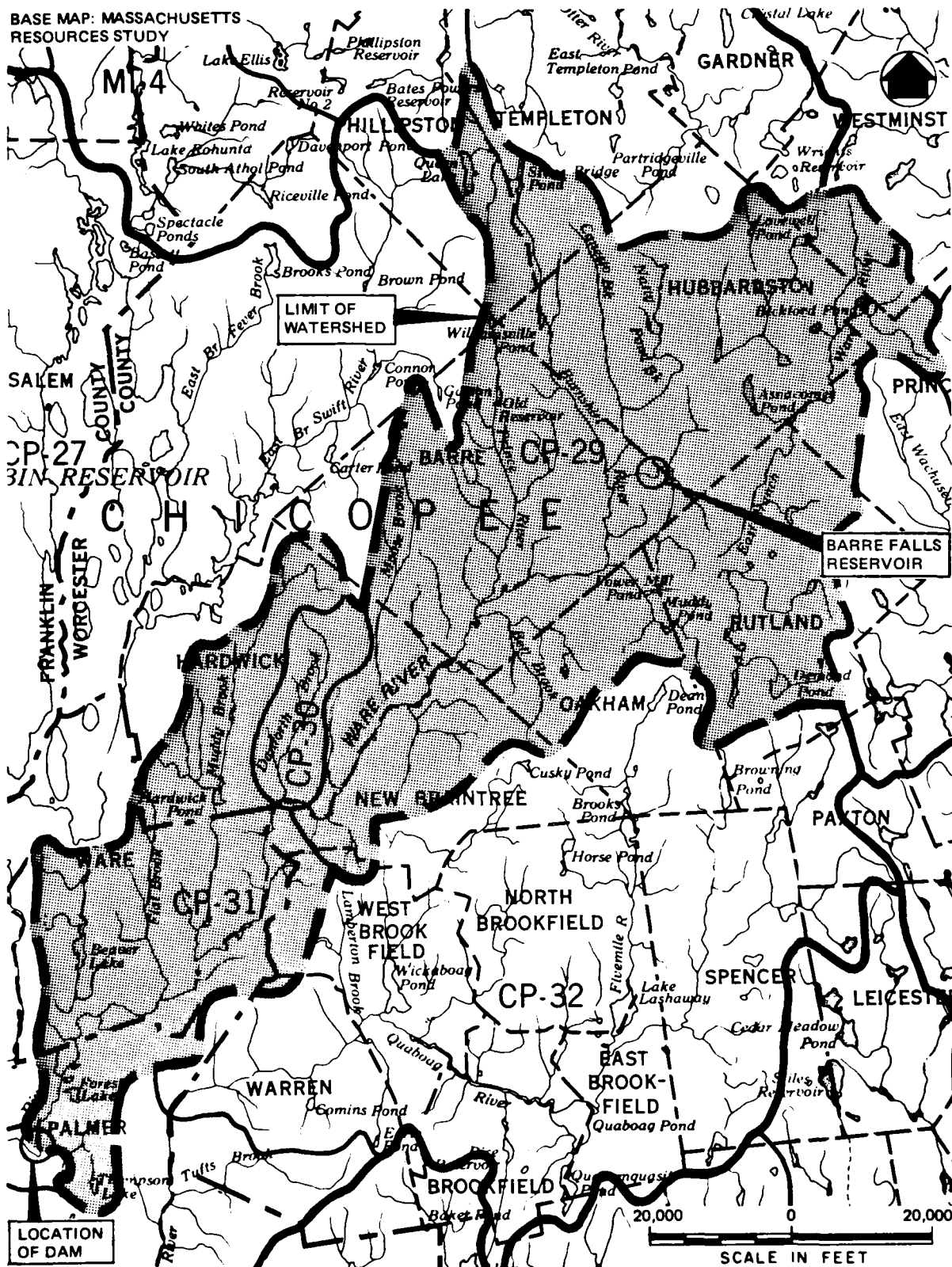


FIG. D-1 DRAINAGE AREA MAP

DIAMOND INTERNATIONAL CORP. UPPER DAM

APPENDIX D
HYDROLOGIC AND HYDRAULIC
COMPUTATIONS

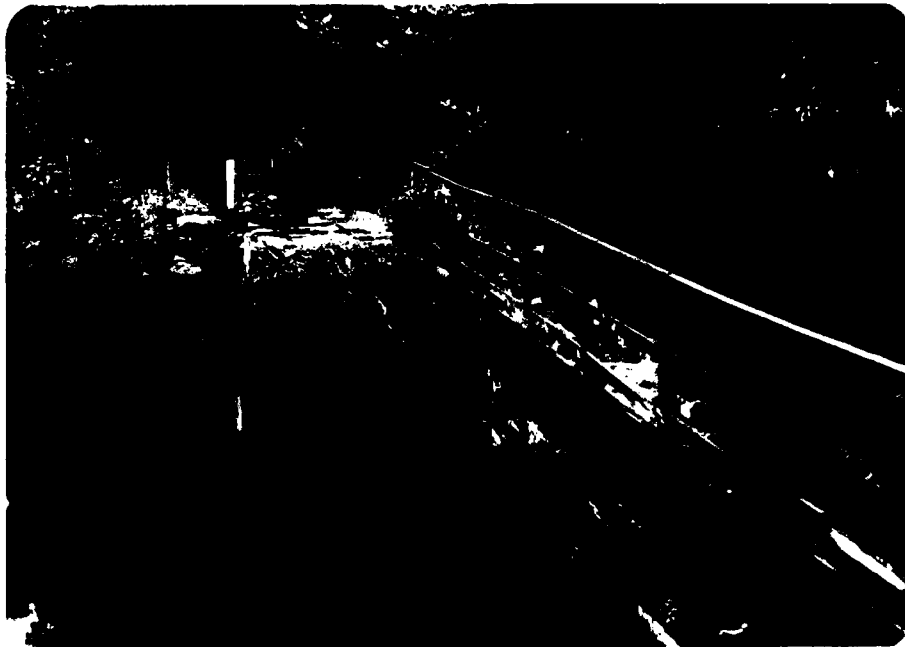
	<u>Page</u>
Figure D-1, Drainage Area Map	D-1
Hydrologic and Hydraulic Computations	D-2



NO. 13 LOW LEVEL OUTLET AT CANAL SPILLWAY



**NO. 14 PLEASANT STREET BRIDGE OVER THE WARE
RIVER (DOWNSTREAM OF MAIN SPILLWAY)**



NO. 11 CANAL SPILLWAY AND LOW LEVEL OUTLET



NO. 12 DOWNSTREAM WALL OF CANAL SPILLWAY

VII

Crest Flow

$$L.P. Crest 368, h_2 = 387 - 368 = 19', d_2 = 379.5 - 368 = 11.5$$

$$d/h = 0.605; n = 0.844, q = 2.55 n^{1.5} h^{1.5} = 163.7 \text{ cfs/ft.}$$

$$Vel. at dnstr. edge \approx \frac{q}{11.5} = \pm 14 \text{ fps.}$$

VIII

Low Level Discharge

There is no low level outlet in the dam. A draw down may be effected by use of the adjacent canal. Any storage reduction below the spillway crest elevation, would have only trivial benefit in lowering test flood levels and discharge.

(IX) Failure of Dam

Peak Failure Flow:

Pond Elevation - 368.0

Toe Elevation - 345.0

$$Y_0 = 23.0$$

Dam Length Subject to Breaching = 250' ±

$$W_0 = 40\% (250) = 100'$$

$$Q_R = 1.68 W_0 (Y_0)^{1.5} = 1.68 (100) (23)^{1.5} = 18500 \text{ cfs}$$

$$\text{Continuing Spill. Disch. : } (74/74) 9210 = \frac{3900}{22,400} "$$

$$\text{Peak Failure Flow: } = 22,400 "$$

Storage Volume Released:

Storage Above Spillway From (X) : 1200 ac. ft.

Storage Below Spillway $\frac{1}{3}(135) 17.4$: 780 " "

Total Storage 1980 " "

Channel Hydraulics:

Depth at bridge : (Ref. V.T. Chow - pg 498 - Fig 17-29)

1- Prefailure flow - 9210 cfs ; $\pm 90 \text{ cfs/ft. bridge opening}$

Opening $\pm 10'$ tall , $H/d = 0.9$, water El = $\pm 345 + 9 = \pm 354$

2- After failure - see (III) - water elev. at bridge ± 363

Failure raises river level 9' at Pleasant St. Bridge

APPENDIX E

INFORMATION AS CONTAINED IN THE
NATIONAL INVENTORY OF DAMS

DIAMOND INTERNATIONAL CORPORATION UPPER DAM



INVENTORY OF DAMS IN THE UNITED STATES

IDENTITY NUMBER	DIVISION	STATE	COUNTY	CONGR. DIST.	COUNTY	NAME	LATITUDE (NORTH)	LONGITUDE (WEST)	REPORT DATE DAY MO YR
562	MA	013	02			DIAMOND INTERNATIONAL CORP UPPER DAM	42 11.5	72 19.5	03 NOV 80

POPULAR NAME	NAME OF IMPONDMENT
WARE RIVER	WARE RIVER

REGION BASIN	RIVER OR STREAM	NEAREST DOWNSTREAM CITY - TOWN - VILLAGE	DIST FROM DAM (MI.)	POPULATION
01 08	WARE RIVER	PALMER	00	11755

TYPE OF DAM	YEAR COMPLETED	PURPOSES	STATUS HEIGHT (FT.)	HYDRAULIC HEIGHT (FT.)	IMPONDING CAPACITIES (ACRE-FT.)	MAXIMUM (ACRE-FT.)	NORMAL (ACRE-FT.)
REPER	1918	S	23	17	1980	780	

JUST OWN FED R PRV/FED SCS A VEN/DATE
NED N N N N N

REMARKS

TO/S HAS	SPILLWAY	MAXIMUM DISCHARGE (FT.)	VOLUME OF DAM (CY)	POWER CAPACITY (KW)	INSTALLED	PROPOSED	NO.	NAVIGATION LOCKS
1	160 U	174	4388	9210				

OWNER	ENGINEERING BY	CONSTRUCTION BY
INTERNATIONAL CO	UNKNOWN	UNKNOWN

DESIGN	CONSTRUCTION	OPERATION	MAINTENANCE
NONE	NONE	NONE	NONE

INSPECTION BY	INSPECTION DATE DAY MO YR	AUTHORITY FOR INSPECTION
WETCALF & EDDY INC	17 JUL 80	PL 92-367

REMARKS
30-ROCKFILL DIKE 34-3351CY ROCKFILL 1037 CY CONC

END

FILMED

8-85

DTIC